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ON GALVANIC BATTERIES FOR MEDICAL PURPOSES.

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THE object of the following pages is not to discuss the value of Galvanism as an agent applicable to the cure of disease, but simply to give to the reader interested in the development of electrical science a general idea of the rise and progress of *physical* electro-therapeutics. I shall confine myself to a short description of the best apparatus now in use, avoiding all topics bearing directly upon the question of how and when to apply the current. Purely medical matters must, for obvious reasons, be strictly reserved for discussion before a professional audience.

The application of electricity to therapeutical purposes is by no means of recent origin. We read in Pliny that the Roman physicians plunged their patients in baths containing electric fishes (torpedo), whose discharges were supposed to be beneficial for the relief of certain diseases.—During the second half of the last century the electric machine was extensively used for curative purposes. In 1746, Muschenbroek, of Leyden, happened to connect a gun-barrel, which he was charging, with the water contained in a tumbler. Holding the latter in one hand he touched the gun-barrel with the other, and immediately experienced a shock, which alarmed him considerably. This experiment created a great sensation among physicists, and led to the discovery of the celebrated Leyden jar. The physiological effects of the electric spark—the powerful muscular contractions which it produces—speedily led to its introduction into medical practice. It was thought that an agent which could throw into convulsions limbs which had been motionless for years must prove a panacea in all kinds of paralytic conditions. But enthusiasm, here as elsewhere, soon overshot its mark, and the publication of innumerable and wonderful cures wrought by the mysterious fluid did much to set up a reaction against its therapeutic applications.

It is a remarkable fact that the existence of current or dynamic electricity also owes its discovery to the physiological effects it produces. "One day," says Dr. Radcliffe, whose graphical account I cannot resist the pleasure of transcribing, "One day in the course of this year (1786), while amusing himself with a common electrical machine near a dish on which lay a number of frogs' legs prepared in the way which it is usual to prepare them for purposes of cookery, Galvani, seeing that these limbs jumped whenever he drew a spark from the primary conductor, was led to think that discharges of atmospheric electricity might make themselves known by similar jumpings. Needing a more delicate electroscope than the one he had, in order to carry out some investigations on atmospheric electricity with which he was then engaged, and wishing to know whether he had found what he needed, he at once took up the dish, with its contents, and went out of doors, his nephew, Camillo Galvani, who was with him at the moment, going with him. The time was a clear and calm evening in September. It did not promise success, for the sky was free from all signs of electrical disturbances. It proved to be propitious in an unexpected direction. The place was a high terrace belonging to the house at Bologna in which Galvani lived—then the Casa Paufili-Colonna, now the Casa Monti, in the Strada S. Gervasio. The house, the terrace, the railings are still to be seen at No. 96 Strada S. Felice, the only change of moment being in the name of the street. Each pair of limbs was suspended by a small (copper) hook from the horizontal bar of the iron railings which fenced in the highest part of the terrace, the hook transfixing the portion of the spine which had not been cut away." . . . *En!* exclaims Galvani, *motus in ranâ spontani, varii, haud infrequentes!*—Lo! movements in those frogs, spontaneous, varied, repeated!

How, from this fortuitous* observation, and the controlling experiments made to establish it, arose, on the one hand, the great discovery of animal electricity, on the other the still mightier invention of the electric pile by Volta, need not be related here. A host of physicists and physiologists pressed upon the footsteps of the pioneers of the new electrical science, and soon covered the ground opened to them. At the same time a new era began for electro-therapeutics—the galvanic or voltaic battery displaced the friction machine and Leyden jars, which still lingered among the paraphernalia of Æsculapius.

But the cumbersome imperfection and want of constancy of the original elements, and the disappointment experienced by many who expected to find in the current the panacea of their dreams, caused the new therapeutic agent to sink into a comparative oblivion, which became complete when the celebrated French physician, Duchenne, introduced the induction currents into medical practice (1847). "Faradic electricity," as the new modification of the force was called in honour of him to whose genius, art and science owe an everlasting debt of gratitude, soon acquired an importance in the diagnosis and treatment of morbid conditions which all our recent advances have enlarged and confirmed. The compactness of the apparatus, and the great physiological energy of the effects obtained from them, has done much to acquire for the induction coil a recognised place in the armamentarium of the physician in all parts of the globe.

Galvanism, however, had in the meanwhile entered

* It has erroneously been asserted that this was the *first* time Galvani ever witnessed the effects of electricity on animal tissues. The pleasing legendary halo thrown about the origin of this, as of other scientific discoveries, somewhat fades in the light of historical criticism.

upon a new phase, thanks to the invention of a constant depolarising element (Daniell, 1836), and to the various and successive improvements by which it gained in durability and in other practical aspects. The untiring zeal of Prof. Remak, of Berlin, who, about ten years after Duchenne's first publication brought out his classical "Galvano-Therapie," accumulated a large mass of experimental and clinical facts which imposed themselves upon the attention of the medical world, though not without a sharp struggle with the ruling power of the day. The result of the conflict was still doubtful when Remak died (1869); but then his influence, as it had been hitherto held latent, became liberated, so to speak, and his labours brought forth an abundant harvest. In Germany there appeared a number of eminent men who, by their thorough and conscientious investigations, placed the importance of the galvanic current in our scientific and practical dealings with nervous diseases, beyond every possibility of cavil. At the same time, as the last echoes of personal rivalries and recrimination were dying out, a reconciliation was effected between the claims of the followers of Remak and those of the disciples of Duchenne. Both forms of dynamic electricity were found to fulfil important indications, and to yield important services in the hands of the physician, and consequently both battery and coil became indispensable adjuncts in the hospital and consulting room, for such, at least, who kept abreast with the rapid advances of nervous pathology. Nay, even the long discarded static machine has lately been restored, under the improved form given to it by Holtz and others as a means of rational treatment in certain disorders.

My intention here is not to speak as a physician, but as a physicist, and to give the readers of this journal some idea of the conditions to be fulfilled by a battery intended to send a current through the human body, and present a sketch of the various improvements recently made in the apparatus designed to meet those requirements.

What electromotive force must such a battery possess? The answer to this question will be found only when we know (1) the strength of current which the organism will bear without damage or discomfort, (2) the resistance of that organism to the passage of the current. Let us take first the question of the resistance of the human body. Now, as I have fully shown elsewhere*, this question does not allow of any definite answer. The resistance of the body varies within wide limits (500 to 100,000 ohms, or more), according to a number of circumstances, the chief of which are, first, the area of the surface offered to the current on its entrance and its exit; second, the thickness and dryness of the skin at those spots. These variations are reduced within comparatively narrow limits in practice, however (though we must be always prepared to find individual divergencies), by the application to the previously soaked skin of electrodes of proper size and construction. With electrodes about 18 square inches the resistance encountered may be said to average 1,000 to 4,000 ohms.—With reference to the strength of the current which may be applied to the body† with comfort and safety, and for periods not exceeding 15 or 20 minutes, experience has shown that they range between 10 and 20 milliampères. Here again we must, of course, assume electrodes of standard size (18 inches square), for it is obvious that the effect of the current on the skin must vary with its density; a quantity of electricity easily borne when diffused over a certain area would cause intolerable pain and produce electrolytic eschars if applied to a single point, or a small surface, even for a short time.

We therefore see that a battery capable of developing an electromotive force of 60 volts, and provided with means of graduation, will fairly fulfil the conditions above mentioned. It is obvious, also, that in presence of the large resistance of the body, and the relatively feeble currents required, the size of the component cells may be diminished without detriment; for the increased internal resistance of the battery, and the small quantity of the exciting fluid, and of the depolarising material they contain, will, within reasonable limits, be no obstacle to the satisfactory working of the battery.

Remak's original apparatus‡ was exceedingly ponderous and inconvenient. Though consisting of 32 cells only it weighed about two-hundred weight, and had to be conveyed on a chariot. The elements were of the Siemens-Halske type, viz., a modified Daniell's, in which the liquids are separated by means of a papier-mâché diaphragm; the periodical cleanings and rechargings they required entailed a considerable amount of labour, and were additional obstacles to the popularisation of the galvanic current as a means of cure. About twenty years ago Stöhrer, of Dresden, made the first medical battery on the pattern which long held the first place among apparatus of the kind. It consisted of an oblong case, with a movable bottom on which rested a double row of glass cells half filled with dilute sulphuric acid. By means of a simple arrangement the cells could be lifted so as to receive each a pair of zinc and carbon plates which were suspended from a longitudinal bar, thus throwing the battery into action. It was found that the rough surface of the comparatively large and porous carbons secured a sufficient check to polarisation, and that the addition of bichromate of potash or bisulphate of mercury was unnecessary, owing to the comparatively feeble currents required.

In this country medical batteries on the Smee principle (zinc and platinised silver) have once had a certain vogue; they were much more compact than Stöhrer's apparatus, but their initial cost was high. Moreover, the use of acids in all batteries intended to be portable has always proved a serious drawback and restricted their use in medical practice owing to the accidental spillings of corrosive fluid which, with the most sedulous care, cannot be absolutely avoided.

In France the well-known electrician, M. Gaiffe, has for many years held a distinguished place for the improvements he has effected in medical batteries. He introduced an ingenious chloride of silver element, consisting of a plate of zinc and a plate of cast chloride of silver containing a silver rod, the exciting fluid being a solution of chloride of zinc. The electrodes, with an intervening pad of bibulous paper soaked in the solution, are bound together with a couple of India-rubber bands, and contained in a cylindrical vulcanite box. No other liquid is required beyond what is held by the pad, so that the element is practically a "dry" one. Nothing can be neater and lighter than the Gaiffe cell; it would be the perfection of a medical element did it remain unaltered when not in use. Unfortunately this is not the case; the zincs get incrusted with oxides which, after a while, put a stop to any further electrical action.

The Leclanché element, and its various modifications, have of late years been largely applied to medical purposes both in England and in France. The cells are made of glass, or of vulcanite, which is lighter, and less exposed to breakages. They measure about 1½ inch in breadth and depth, and 4 inches in height. The manganese is either loose or pressed into small conglomerate plates. When thoroughly well made such cells fulfil very well the requirements of the physician, who works his batteries intermittently, and through high resistances.

I have recently seen a new arrangement by Chardin, of Paris, which is both ingenious and effective, as it unites the advantages of the Leclanché and Stöhrer types of batteries, the former being eminently portable, the latter easily taken to pieces and charged. The cell

* "A Practical Introduction to Medical Electricity." 2nd Ed., p. 43. H. K. Lewis, London, 1884.

† At least for the trunk and limbs; much weaker currents only are tolerated in the neighbourhood of the brain.

‡ I am speaking here of the "portable" one which he used to give his celebrated demonstrations in the Paris hospitals in 1864. His fixed batteries were much larger and heavier still.

is formed of cylindrical glass vessels, like a large test tube, half filled with water, into which a quantity of sulphate of mercury is added. Two corks of a diameter slightly inferior to that of the tube float in the liquid, the film of air between the two effectually preventing spilling when the battery is tilted. The cells are arranged in rows, in a box, on a movable bottom which, when lifted, sets the battery in action by bringing the electrodes in contact with the exciting liquid. Those electrodes consist of small pencils of zinc and carbon fixed to the upper part of the box; when the tube is lifted up they press upon the corks which are forced to the bottom of the tube, displacing the liquid upwards.

A complete medical battery is fitted with an arrangement called a *collector*,* which enables the operator to diminish or increase at will the number of cells in circuit, so as to regulate the strength of the current according to the requirements of each case. Collectors are of various types, the most familiar having the appearance of a dial: wires connect the cells, taken singly or in pairs, to a series of metallic studs, numbered and arranged in a circle around a pivot on which revolves a switch. One of the terminals is connected through the first stud (marked 0) with the first cell, the other with the pivot; the free extremity of the switch being then made to rest on the stud corresponding to the required number of cells, the current is thus graduated with ease and rapidity. In order to avoid a break every time the switch is made to pass from one stud to the next, the free extremity of the spring which terminates it is made broad enough to touch one stud before leaving the other. This is a very important matter, for in numerous medical applications (*e.g.* to the face, eyes, ears, &c.) such shocks as would be produced by sudden makes and breaks are to be carefully avoided, and the current to be brought up to the desired strength, and again reduced to zero by insensible steps.

Another accessory of importance in the medical battery is the *current-reverser*, which enables one to alter the polarity of the rheophores and electrodes, and thereby the direction of the current through the body, without disconnecting and reconnecting them each time. The physiological effects of the anode and the kathode are very different, and the discrimination between them is of the utmost importance in the diagnostic uses of the galvanic current. Moreover, the "voltaic alternatives," as those sudden reversals of the direction of the current through the body are called, have recently been shown to be of far greater importance in the treatment of certain disorders than former observers thought. They excite muscles and nerves very powerfully, and it was believed that their use was fraught with danger; but here, as elsewhere, actual observations have shown how preconceived theories, even when most plausible, may be opposed to the data of experience.

A *galvanometer*, or at least a galvanoscope, should form a *sine quâ non* adjunct to the battery. I say *should*, because the fact is unfortunately not yet fully recognised, especially in England, both by those who make and those who use medico-electrical instruments. The necessity of current-measurements when the human body forms part of the circuit is so evident a fact to any one conversant with the behaviour of electricity in such conductors of variable resistance need not be insisted upon here. I proposed, in 1878, the adoption of the milampère (then called milliweber) as a convenient unit to express the strengths of current used in medical applications, a suggestion that has since been embodied in the report of the special committee of the late International Electrical Exhibition in Paris. Medical galvanometers may be now obtained graduated in milampères, the most perfect instrument of the kind I have seen being one made by Edelmann, of Munich. The magnet, made in the shape of a bell with a double longitudinal slit, is suspended by a short silk thread in a copper tube round which the coils are disposed. It is almost absolutely dead beat, a characteristic of the highest practical utility for the purposes which it is intended to fulfil. By means of shunts the sensibility of the instrument may be made equal to 1, ·1, ·01. The dial has been subdivided experimentally in such a way that the current is indicated in milli-, centi-, or deci-ampères (from 1 to 5 in each case) according to the shunting. For all ordinary purposes, however, a much simpler instrument will prove amply sufficient, provided it be constructed so as to indicate currents from 1 to 25 or 30 milampères.

Finally, our battery will require some further accessories in the shape of "rheophores" to conduct the current to the body, and "electrodes" or contrivances of the requisite size and shape to bring the skin into close apposition with the distal end of the rheophores. The full discussion of these matters would lead me into professional details unsuitable for these pages. Suffice it to say that rheophores are conveniently made of telegraph wire, well insulated with India rubber; and that the electrodes (called so because the human body behaves like an electrolyte in the circuit), when intended for application to the limbs or trunk, consist of good sized plates of soft and pliable metal, enclosed in chamois leather (well wetted, since the dry epidermis, or horny layer of the skin, acts as an insulator), or of metallic discs or knobs, similarly covered, when the current has to be localised upon smaller areas. In all ordinary medical applications the strength and density of the current, as well as the time of its flow, are so managed as to avoid any destruction of the skin by the electrolytic action. When, however, it becomes our object to produce electrolysis (as in the treatment of tumours, naevi, and the like), needles are inserted into the part, so as to concentrate the chemical action of the current upon a small portion of tissue. This method must not, however, be confounded with "galvano-caustics" where the current is not sent through the body itself, but through a loop of platinum wire, which thereby becomes incandescent, and is used as a cautery. The battery required for this purpose will necessarily be totally different from those just described. The most convenient consist of two or four bichromate of potash cells with very large surfaces.

* The reader will find all the apparatus described here illustrated in the work above mentioned. As manufacturing medical electricians in London I may mention the names of Mr. Thistleton, 1, Old Quebec Street, W., and Mr. Schoth, 232, Euston Road, N.W. Of the innumerable makers of galvanic, magnetic or electropathic chains, bands, brushes, pads, *et hoc genus omne*, the less said the better.

THE HISTORY OF THE TELEPHONE.

MR. E. BERLINER, well known to those of our readers who are versed in telephonic matters, has sent the following communications to the *Electrical World*. This gentleman's remarks concerning Bourseul will doubtless be specially interesting to one of our most distinguished scientists who has so warmly espoused the cause of Reis.

Mr. Berliner says:—

The general impression having at all times been that Reis was unacquainted with Bourseul's ideas relating to the electrical transmission of speech, and that he was an original inventor, the following article from the *Didaskalia*, a semi-weekly printed in Frankfort-on-the-Main (the abode of Reis from 1848 to 1854), a paper devoted to belles lettres, arts and sciences, and which in its time had a large circulation throughout Middle and Southern Germany, will be interesting to all electricians.

The article is from the 32nd volume of the *Didaskalia*, in No. 232, and the issue bears the date Thursday, September 28, 1854.

The undersigned has prepared a verbal translation of this remarkable document, and through the kindness of the editor of this paper has commented on it in another colum of this issue.

E. BERLINER.

DIDASKALIA. 32nd volume. No. 232. Frankfort, September 28, 1854. *Electrische Telephonie.*

The wonders with which electricity has surprised us lately will, as it seems, be augmented by a new one which will not only produce a revolution in the present electrical telegraphy, but will also enhance its utility in an incalculable manner. It concerns nothing more or less than the electrical transmission and rendition of the *spoken word*. The idea originated with a young and

modest but educated man, Charles Bourseul, who in 1848 was a soldier of the African army, where he made himself observed to the Governor-General by a mathematical course which he gave to his comrades of the garrison in Algiers; he now lives in Paris. Perhaps Bourseul's problem, of the feasibility of which he is perfectly convinced, belongs to the line of those discoveries which the learned world afterward declares as very simple, and of which they would then make us believe would have been found out much earlier if they would have taken the trouble (to find it). As we know, the principle on which electro-telegraphy is founded is the following:—

An electric current circulating in a metal wire transforms a piece of soft iron with which it comes in contact (?) into a magnet. As soon as the current ceases, the magnetic quality gives way. This magnet, the electro-magnet, can therefore alternately attract and let go a movable plate which, by its motion of coming and going, produces the conventional signs which are used in telegraphy.

It is furthermore known that *all* tones are communicated to the ear merely by undulations of the air, being, therefore, themselves nothing but these undulations of the air, and that the differences (without end) of the tones depend solely and exclusively on the rapidity and the strength of these sound-waves. If, now, a metal plate could be invented so movable and flexible as to render all the tone undulations equal in the air, and if this plate be so connected to an electric current that it would alternately make and break the electric current according to the air undulations by which it is struck, then it would be possible to cause a second similarly constructed plate to electrically repeat at the same time exactly the same undulations as the first plate, and it would therefore be the same as if a person had spoken in the immediate neighbourhood against this second plate, or the ear would be affected in the same manner as if it received the tones communicated through the first metal diaphragm (*mettallwand* = wall, partition, E. B.). The electrical telegraphy which at the time was stamped, academically, almost as nonsense, now traverses the whole world as a familiar phenomenon. If we consult, in regard to this new idea of a young physicist, the principles of physics, we have not only nothing to say against the possibility of its execution, but its success seems more probable than did electrical telegraphy not long ago.

If the experiment succeeded, then electrical telegraphy would have become quite good; it would require no other machinery and knowledge than a galvanic battery, two vibratory plates and a metal wire; without further preparation one person would have only to speak against the one metal plate and the other person to hold his ear to the other, and thus they could converse one with the other as under four eyes (*unter vier augen* = personally).

The young inventor believes in the success of his endeavours, and challenges the learned men to prove that the laws of physics are in contradiction with the above recited principles, and that they let appear impossible what is looked for.

In the meantime this matter would deserve the attention it will receive, in the highest degree.

(Signed) L.

EXIT REIS.

To the Editor of The Electrical World.

Sir,—In ancient Rome there was at one period a law forbidding the erection of a monument to a man until one hundred years after his death.

The meaning of this law was, no doubt, to wait before immortalising the work of a citizen until a good general aspect and a broad view of the true value of his life could be obtained by looking at him from a distance. It is too often the case with men's judging a person or a cause, that they are in the position of the peasant boy who could not see the forest on account of the trees. Views are narrow, the horison is limited, and they lose sight of the great panorama of life and progress, and imagine that it is their own work and sphere around which revolves everything else. On the other hand, the true value of a man's life is often not recognised until many years after his death. But worse than the errors arising from a natural narrow-mindedness is the practice of many of the genus *literarius* to paint before the eyes of their readers an artificial perspective, to use the richness of language, the flexibility of syntax and the wiliness of misapplied and overturned philosophy to enhance the scenery and to put the glare of a calcium light and the romance of a stage moon as a halo behind the heads of their heroes. Let on the daylight of investigation and ventilate with a short blast of logic, and the true inwardness of the charming romance is laid bare. Witness Louise Muhlbach's touching historical novels and turn upon them Carlyle's studies and criticism. The monuments were only sticks and pasteboard, and fall into a dozen pieces when you draw the pedestal from under them.

When you, Mr. Editor, in the issue of the *Electrical World* of October 6, 1883, said:—"In a controversy of this kind (the Reis-Bell) it is never too late to take evidence," I did not dream that so soon afterwards I should come across an old semi-weekly newspaper published at Mr. Reis's doorsteps, and which, printed fully five years before he commenced original researches, contained, under the heading "Electrical Telephony," nearly the whole of the scientific arguments, though in sketch-like brevity, which in 1861 Mr. Reis gave out in his well known lecture.

This article, which by your kindness is printed in another column, written by one signing himself "L.," and which appeared on Thursday, September 28, 1854, in the *Didaskalia*, a paper printed in Frankfort-on-the-Main, and widely read throughout Germany, contains so lucid a description of Bourseul's idea of a telephone, that any mechanic knowing how to harness electricity can produce from the ideas given a musical telephone.

And five years afterwards we find Philip Reis make such apparatus and say that he invented it and named it "telephone."

In order to be able to judge this most strange part in the history of this most remarkable invention, I beg to place before the reader an abstract from Prof. Sylvanus P. Thompson's book, "Reis: the Inventor of the Telephone," and which book I have had the pleasure ere this to comment on in the columns of the *Electrical World*.

According to Prof. Thompson's original researches:—

Reis was born in 1834.

"Went to Frankfort in 1848."

"Became a member of the Physical Society of that city in 1851, and remained three years a member thereof."

"In the winter of 1854–5 we find him most zealously busied with preparations for carrying out his decision to become a teacher."

"In 1855 he went through a year of military service at Cassell."

It was during this time (1859) that Reis undertook the first researches of an experimental nature."

"In 1859 he sent a paper to Prof. Poggendorff, entitled, 'On the Radiation of Electricity.'"

The other piece of original work undertaken at this time was the research which resulted in his great invention—the telephone. From the brief biographical notes written by the lamented inventor in 1868 we extract the following:—

"Incited hereto by my lessons in physics I attacked a work begun much earlier concerning the organs of hearing, and soon had the joy to see my pains rewarded with success, since I succeeded in inventing an apparatus by which it is possible to make clear and evident the functions of the organs of hearing, with which also one can reproduce tones of all kinds at any desired distance by means of a galvanic current. I named the instrument 'Telephone.'"

What I now ask is:—

Can we assume that Reis, belonging to the cultured class of a city of 60,000 inhabitants, did not read a semi-weekly paper of that city devoted to belles lettres and daily events?

Can we assume that Reis, having been from 1851 to 1854 an active member of the Physical Society and leaving Frankfort in 1855, did not read or hear of the wonderful and novel ideas presented in Frankfort in September, 1854, under the name Electrical Telephony?

Shall we assume that Reis wrote the article himself over the signature "L.," and afterwards, ignoring Bourseul, took all the honour to himself?

But even assuming the latter case for a moment, how can it be explained that instead of employing the powerful alternate attraction and release of a diaphragm by an electro-magnet for a receiver, so plainly hinted at in 1854, he, in 1860, resorted to the feeble vibrations of a needle core?

Here are enigmas which Prof. Thompson can possibly unravel. But to save Reis's good name, let us assume that he either hastily read or heard of this article, that with most of his colleagues he shook his head at the idea of transmitting speech by electricity, and that fully five years afterwards, having completely forgotten about it, the idea unconsciously re-occurred to him, and was this time judged by him with a mind more mature for physical researches and more free of other immediate changes and aims. But whatever conclusion we arrive at, Reis cannot be taken as the inventor of even the musical telephone. This honour belongs entirely to Bourseul, and Reis was practically only Bourseul's assistant, and merely carried out the mechanical parts of the problem.

Prof. Thompson closes the preface of his book with the sentence: "When the jubilee of Reis comes to be celebrated in 1884, the world will find out its indebtedness to the great man whose thoughts survive him."

Does the reader who has followed my controversy with Prof. Thompson in its scientific and logical, and presently in its historical bearing, comprehend now the wisdom of the ancient Roman usage, not to erect a monument to a man until 100 years after his death?

We will at any time have a word of welcome for Prof. Thompson for any of his "original researches," but had they not better remain confined to experimental physics?

Reis was after all only the foster father of the "child in the wilderness." E. BERLINER.

Washington, D. C., *May 31st*, 1884.

ILLUSTRATIONS OF ELECTRICAL PHENOMENA.

MR. REYNOLD JANNEY, of Wilmington, O., writes to the *Scientific American* that, having occasion to illustrate in a lecture some of the phenomena of atmospheric electricity, he desired to obtain as long sparks as possible. With the apparatus at hand the longest spark he could obtain in air was 4¼ inches. He tried iron filings sprinkled on varnished glass, paper, and wood,

but the results were not satisfactory. After several experiments he hit upon the following exceedingly successful method :—

Dry boards were fastened together to make a plane surface, 4 feet long and 3 feet wide. One side of this was varnished, and before it was dry Mr. Janney pressed over its entire surface sheets of tin foil. After letting it stand over night to dry slightly, with a ruler he passed a sharp knife across the foil in lines about one-eighth to one-quarter inch apart. Allowing it to dry again a short time, he passed the knife across it right angles to the former lines, thus cutting the foil into squares, separated by very short distances—only the thickness of the knife edge. Connecting the poles of his coil to opposite ends of the board, a phenomenon of dazzling beauty was produced. Every time the circuit was broken, from six to 20 lines of sparks zigzagged from one end of the board to the other. These were exceedingly brilliant in the dark, when the circuit was broken only about 180 to 200 times a minute. Judging from the resistance of vacuum tubes placed in the circuit at the same time, the experimenter believes that he can obtain strokes from 15 to 20 feet in length by this method, if the foil be placed in a narrow strip along a pole of that length.

The drying mentioned above is necessary, as it is very slow under the foil, and the strips will be pulled out of their places in the second cutting. The coil contains about 30,000 feet of No. 36 naked copper wire. The circuit breaker is a combination of the ordinary platinum contact break and a mercury break, so that either can be used at will. The mercury break produces much better effects. It consists of a platinum wire dipping into mercury covered with alcohol.

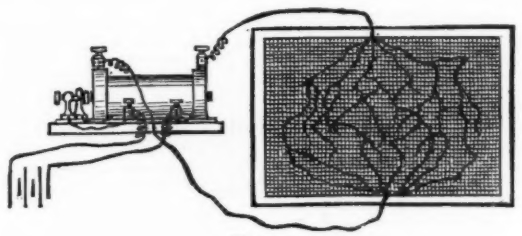


FIG. 1.

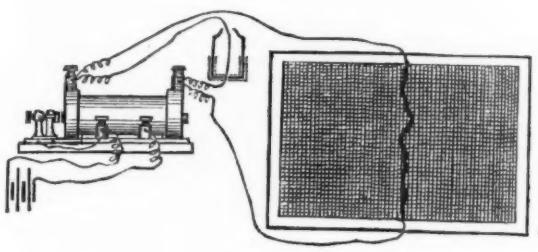


FIG. 2.

The condenser consists of 40 sheets of tin foil, 6 inches by 12 inches, with varnished paper between.

The battery consists of three cells of the Grenet type, each containing about 50 square inches of zinc surface, counting both sides.

With this battery and coil Mr. Janney obtained strokes in air $4\frac{1}{2}$ inches long between a brass disc $1\frac{1}{2}$ inches in diameter, and a point.

Over a tin foil surface as described he obtained a stroke 10 feet long, with sufficient force to make it much longer had he had a greater length of tin foil.

There is one peculiarity about these strokes depending upon the connections. If the opposite ends of the board covered with the foil be connected directly with the poles of the secondary coil, the discharge seems to scatter over the whole surface, making several simultaneous strokes and producing a very beautiful appearance. (See fig. 1.)

If the connections remain as in fig. 1, but also the poles of the coil be connected one with the inside and the other with the outside of a small condenser containing about 4 to 6 inches of tin foil, the electricity no longer scatters over the board, but makes only one much more direct and more intense stroke. (See fig. 2.)

ON A NEW DYNAMO-ELECTRIC MACHINE.

By MM. A. DAMOISEAU AND G. PETITPONT.

THE importance, as far as the yield is concerned, of minimising the quantity of work converted into heat in the wires of dynamo machines is too evident to require enforcing.

As the production of a given magnetic field with an electro-magnet of given dimensions requires always a certain outlay, we cannot think of effecting this reduction on the inductors. The armature alone is open to modifications which enable us to obtain a greater electromotive force in an equal length of wire traversed by the current.

The arrangement which we have devised for this purpose is the following, and is applicable to the machines of Pacinotti, Gramme, Hefner Alteneck, and Siemens. The expansions of the poles are suppressed, and the poles are approximated to one another so as to affect merely a portion of the ring, the fourth or the eighth. The current is then received at three points of the collector, one in the middle of the part corresponding to the portion of the ring affected, and the two others at either hand of each pole.

Under these conditions, if the inductors are excited by an external source of electricity, and the ring revolves in the direction of the brushes, α, β, γ, if the circuit is open, the difference of the potential between α, β, γ remains the same. But if we close the two circuits with resistances which are equal, and decrease gradually, α β preponderates, and that in a very decided proportion, nearly one-half. If we render the resistance at α β smaller the difference is still more striking. But if we diminish the resistance at γ β we perceive, taking account of the loss due to internal resistance, that the proportion of the electromotive forces does not sensibly vary. The intensity of the current circulating between α and β diminishes the electromotive force at γ β without the reciprocal force being sensibly noticeable. The differences of potential between the extreme brushes, though they sometimes attain considerable values (more than 100 volts in a machine now constructed), only generate a current in the inactive part of the ring which may be practically neglected.

We may therefore, for instance, utilise the current γ β to excite the inductors, and we thus obtain a machine which acts approximately as if it was excited in derivation, and which gives, all other things being equal, with an equal linear velocity, and an equal length of wire traversed by the current, an electromotive force greater by one-third than that which is obtained with the best machines now made.

We have constructed a model in which the ring (of the shape of a disc) has 3·200 kilos. of wire of 1·2 millimetres in diameter, and the electro-magnets 18 kilos. of wire of 1·6 millimetre. The polar surfaces are only 56 square centimetres each, and act upon the ring at its two surfaces. The length of the wire between the two brushes is only 45 metres. With the electro-magnets connected two by two we obtain, at a speed of 690 revolutions, 11·7 ampères, and 64·5 volts at the terminals. At a speed of 1,854 we obtain 207 volts with an open circuit, and at 1,900 revolutions 180 volts at the terminals, and 23·5 ampères with a resistance of 7·5 ohms. The electric yield is, under these conditions, 0·763, or the machine produces more than 200 watts per kilo. of coiled wire, which represents a work about double that produced by present machines with a lower yield (0·71, 0·677, 0·684 being the yields of the machines IV., V., and VI., experimented with by the Committee of the Exhibition of 1881.) — *Comptes Rendus.*

NOTE ON THE THEORY OF DYNAMO-ELECTRIC MACHINES.

(*Concluded from page* 499.)

Search after the Lightest Type of Dynamo-electric Machine.

FOR this purpose we must return to the theory of dynamo-electric machines, and seek to penetrate further into the knowledge of the magnetic phenomena which determine the production of the current.

1. *On the Armature.*—We may consider this as a revolving body, which turns on its axis; the polarity of its different points ought to remain independent of its rotatory movement.

The best armature must be that which will render it possible to place the greatest quantity of copper in the midst of the active part of the magnetic field developed by the inductors.

But whatever may be the method of coiling adopted, that of Gramme or of Alteneck, the only portion of the armature which is necessarily withdrawn from the action of the inductors must be that which abuts on the piece of a diamagnetic substance which serves to support this armature.

Thus it may be said that, from this point of view, all systems of coiling are equally good.

As for the proportions which ought to be established between the masses of copper and of iron in the constitution of the armature, we shall treat of them at the same time as the inductors, since the latter take an active part in the production of the magnetic field in which the armature moves.

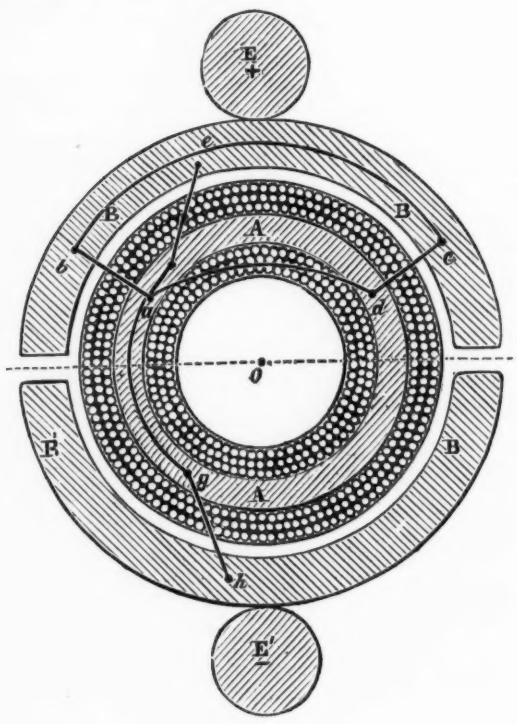


FIG. 5.

On the Inductors.—The object sought is to saturate the magnetic field in which the conductor of the ring is displaced at the smallest possible outlay of energy. But we have seen that the saturation can be effected by means of a very feeble current circulating around the inductors, but that this result is in part destroyed by the magnetisation of the ring. It is easy to account for this phenomenon.

Let us suppose a Gramme ring, A A (fig. 5), capable of revolving between two polar pieces, B B, B′ B′, and let us suppose that the space included between the ring and these pieces is completely saturated when we pass a certain current around the inductors, E E′, the ring itself not being traversed by any current.

If we cause a current to circulate in this ring, there will be produced two poles diametrically opposite. But the lines of force issuing from the positive pole, on their way to the negative pole, such as *a b c d*, will tend to effect the greater part of their course by the medium of the polar pieces, B B, or B′ B′. The actions of the parts *a b* and *c d* upon the conductor of the ring neutralise each other reciprocally, but these two lines will take the place of two lines of active forces, previously developed by the inductors, E E′, the energy of the magnetic field will therefore be diminished.

To do away with this defect, it is necessary to increase the current which circulates round the inductors, or, in other words, to expend more work. When these are thus rendered stronger they again become masters of the available field and force the lines, *a b c d*, to take a new course, such as *a m d*.

There is still another defect which it has been sought to remedy by modifying the lead of the brushes when the intensity which circulates in the ring increases. Under the influence of the poles developed in it, the lines of force emitted by the inductors deviate perceptibly from a direction normal to the ring and take directions more or less oblique, such as *e f g h*. But we know that *the electromotive force developed in a given conductor is not merely proportional to the number of lines of force which it encounters during a unit of time, but it is also a function of the angle at which it intersects them, and that the electromotive force reaches its maximum when this is a right angle.* The field being kept saturated by the inductors cannot, however, develop the same effects, and the change of lead of the brushes merely renders it possible to collect all that can be developed in a field thus constituted.

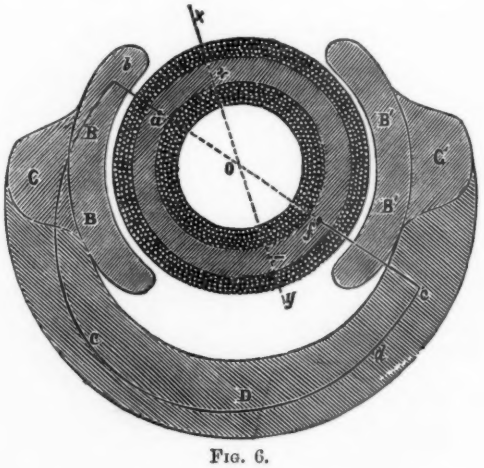


FIG. 6.

These defects, common to all existing dynamo machines, depend on the fact that both require two distinct magnetic systems, which cannot be developed save at the expense of each other. But we must not forget that the object in view is to saturate a limited volume, and that we may gain this end by merely employing one of these two magnetic systems.

We cannot withdraw the iron from the ring without rendering the saturation of the space in which the conductor moves almost impossible; it, therefore, alone must determine it. In other words, whilst preserving the polar pieces, B B, B′ B′ (fig. 6), we must connect them directly by masses of iron such as C D C′, suppressing the electro-magnets of the inductors.

If, then, on placing the brushes suitably we determine two diametrically opposite poles in the ring, as represented in the figure, the lines of force which tend to pass from one to the other will follow a track such as *a b*, *c d*, *e f*. The piece, C D C′, being inert, will not hinder their development, and if it admits of so much

iron that the number of lines of force capable of fully saturating the interval between it and the ring are far from saturating it (*i.e.*, the inert piece), all the directions, such as *a b* and *f g*, should coincide with the radii, *o a* and *o g*.

We are thus led to think that we may improve the yield of the machines of Siemens, Gramme, and others, of suppressing their present inductors, and substituting for them polar pieces analogous to those which we have just described. Fig. 7 represents a Gramme machine transformed in this manner. We thus not merely ameliorate the yield of the machine since we diminish its resistance, but we increase its power, since its characteristic would not be further lowered. At the same time we diminish its weight and its cost in very considerable proportions.

To the end that the ring may tend to displace itself, it is evidently requisite that the two pole pieces should not enclose it entirely. It results, from the experiments of M. Marcel Deprez, that the development of each pole piece should be about one-fourth that of the ring. A part of the field developed by the ring will thus not be utilised, but if we refer to the investigations of Prof. Sylvanus Thompson, we see that the lines of force issuing from the extremities of the armatures of ordinary machines, either do not meet the ring at all, or intersect it only at very acute angles.

Nevertheless, this transformation may not be applicable to generators whose armatures contain but very little iron.

Let us consider the characteristic of any machine whatever, fitted with its present inductors. Let O, M, A, (fig. 8) be this curve, and let us trace with the same ordinates the characteristic of the same machine, transformed according to our method, and taken at the same velocity. For low intensities the magnetic field will evidently be more dense in the first place than in the second; the first characteristic must, therefore, pass above the second. But when the magnetisation of the ring is strong enough to saturate the field the two curves must intersect each other, say in M, and from this point the second characteristic will remain always above the first, since the corresponding magnetic field will not be weakened, and will approximate closely to the parabola indicated by the theory.

But if O R is the right line whose angular coefficient represents the internal resistance of the

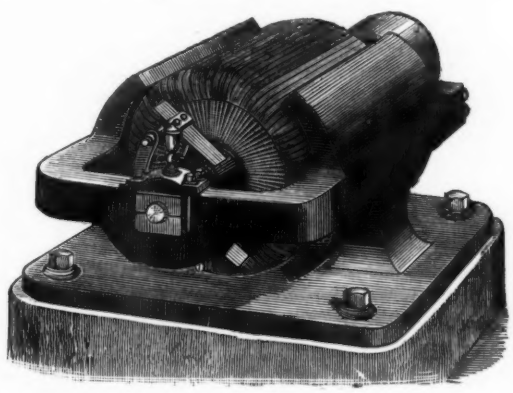


FIG. 7.

machine, the latter cannot prime itself unless it is turned more swiftly.

This method of transformation may, at least, be applied with advantage to existing recipient machines, when their armatures contain sufficient iron.

If we have now to construct a new machine, instead of reducing as much as possible the mass of iron in the ring, we make it very large. This will have, in the present case, no inconvenience, and will permit us to saturate the magnetic field with very low intensities. In this manner the characteristic rises rapidly from its origin.

We must also take into consideration the following remark:—

Since it is the ring alone which determines the magnetic field we must arrange it so that each of its two halves, which acts as an electro-magnet, may be in the best and most productive conditions for such apparatus.

It results, from the experiments of M. Marcel Deprez, that electro-magnets should be made short, but thick, and that the length of the core should not be more than three times its diameter. These conditions cannot be realised with the ordinary type of armatures, since 3 is much smaller than π; there is, therefore, room for creating a much greater number of poles in the ring, always in even numbers. In other words, it is advisable to construct multi-polar machines.

In all machines now in use the inductor electro-magnets have a form quite independent of that of the induced. Ordinarily they are far removed from, and the lines of force to which they give rise are brought back towards, the induced parts by means of powerful armatures of wrought or cast iron, which must at the same time distribute them around it.

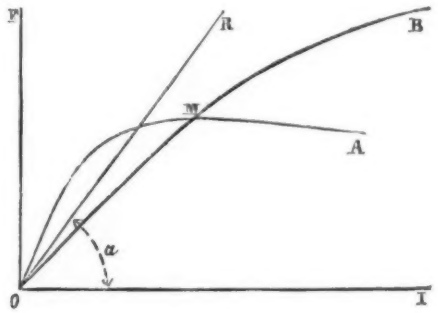


FIG. 8.

These armatures are bulky. In machines of small dimensions, their weight is unimportant, but in large machines, like that of Edison mentioned above, they become enormous blocks of metal of great weight. The greater the mass which is given to the armatures, the more iron also must be given to the inductors, otherwise the magnetic field would be diluted in these armatures. This is the reason why many multi-polar machines have been latterly constructed.

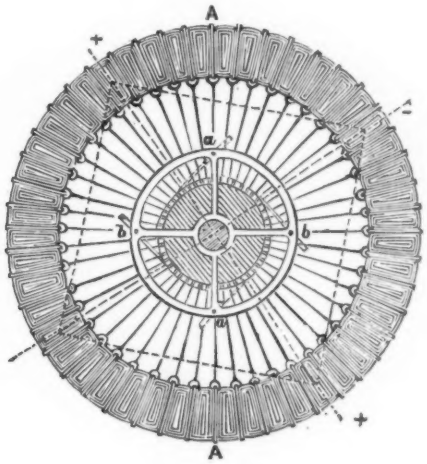


FIG. 9.

These reasons led us to examine if it might not be possible to realise a machine in which the induced and the inductor of our system might not in some manner be the one enclosed in the other, and where all the masses employed might co-operate directly in the development of the magnetic actions, and not in their transmission.

It seemed to us evident that such a machine would be the lightest possible for a given power.

But the sectional solenoid, of which M. Marcel Deprez made an apparatus similar to a steam-hammer, corresponded perfectly to the plan which we had traced. This machine was remarkable for the greatness of the effects which could be produced with masses of a feeble weight, and the small amount of energy which had to be expended to obtain these effects.

Unfortunately, it is impossible to transform this kind

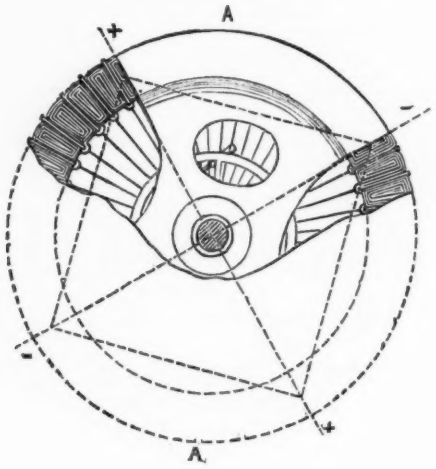


FIG. 10.

of a machine into a machine for continuous circular movement without employing the arrangement devised by M.M. Gerondo, and subsequently re-discovered by M. Deprez, and which is very complicated.

The following type of machine then occurred to us.

Let fig. 9 represent a Gramme ring of a flat section, A, A. This ring is fixed, and the entrance and exit wires of each of its bobbins are connected as usual with each of the successive keys of a collector, which is also fixed.

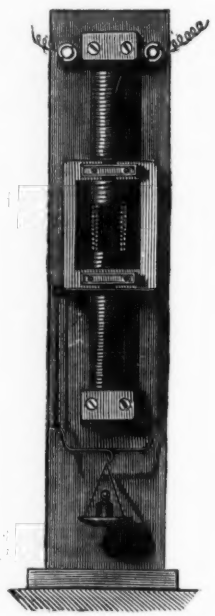


FIG. 11.

Upon this collector there are arranged brushes, $\alpha\,\alpha\,\ldots\,\beta\,\beta\,\ldots$ in even numbers. We number them $1, 2, 3 - 2n$.

Suppose that all the brushes of the odd numbers, $\alpha\,\alpha\,\alpha\,\ldots$ are in permanent connection with one of the poles of a generating machine, and the brushes of the even series, $\beta\,\beta\,\beta\,\ldots$ with the other pole.

It is evident that the current will develop the ring on a series of successive points situate at the apices of a polygon of $2n$ sides inscribed in the median circle of the ring. These points will be alternately positive and negative, as shown in the figure.

All the brushes, $1, 2 \ldots 2n$, being fixed in the same circle, we can cause them to turn simultaneously in one direction or the other.

Whilst doing this we shall also displace our series of points in one direction or in the other.

Suppose that opposite to this ring we arrange a series of n sectors of iron, like that represented in fig. 10, and mounted on the same axle of rotation.

Our successive series of points occupy now given positions in the space, and these sectors will tend to turn until their centre is in the middle between two consecutive poles.

If, by means of the brushes, we displace the successive points in a continuous manner, we thus occasion the rotation of the sectors.

To transform the above system into a dynamo-machine, it is sufficient to key the circle which carries the brushes upon the axle of the sectors.

In such a machine, the iron sectors whose magnetisation remains constant form the inductors, and these of themselves answer the purpose of an armature.

A preliminary experiment made under these showed that the effects obtained were satisfactory, but the outlay of energy required was very considerable.

Having had occasion to consult M. Marcel Deprez, he advised us, whilst retaining the same fundamental principles, to modify entirely the arrangement adopted; to substitute for the flat ring an upright, and for the armatures parallel to the plane of the ring, armatures perpendicular to this plane and connected together by cheeks of iron.

In order to judge of the effects obtained by this alteration, we had constructed the small experimental apparatus represented in fig. 11, in which we made use of all the indications furnished by M. Deprez.

This apparatus is composed of a core of iron of 50 millimetres in diameter and 450 millimetres in length, covered with three bobbins, each 150 millimetres in length and 12 in thickness. The whole was enclosed in a brass tube.

The bobbins being suitably grouped, two poles at 150 millimetres were developed at each extremity of the cylinder.

The armature (the form of which is distinctly seen) was brought into their presence, and a very simple arrangement (also shown in the figure) enabled us to measure immediately the effort developed.

The following are the results of some experiments made with this apparatus, in which M. Deprez varied successively the thickness of the armatures.

1. The armatures and the two vertical cheeks have a thickness of 20 millimetres:

Resistance of the conductor . .	19 ohms.
Intensity	5·29 amperes.
Weight raised	4·3 kilos.
Number of kilogrammetres expended per kilo raised ...	6

N.B.—Two-thirds only of the total outlay of energy took part in the production of the effort. In fact if we had a ring in place of a portion of a cylinder we should have a number of armatures equal to that of the bobbins, but here we had only two armatures for three bobbins.

2. The armatures are 30 millimetres in thickness, and the cheeks 20 millimetres:

Intensity	4·7 amperes.
Weight raised	6·7 kilos.
Number of kilogrammetres expended for kilo. raised ...	4·2

3. The armatures are 40 millimetres in thickness, and the cheeks 20 millimetres:

Intensity	4·5 ampères.
Weight raised	7·6 kilos.
Number of kilogrammetres expended per kilo raised ...	4

These two last results appear remarkable, considering the smallness of the apparatus which weighed only 19 kilos, *i.e.*,

Iron core	5·2 kilos.
Conductor	6·
Armatures of 40 kilogrammetres in thickness, and cheeks of 20 ...	7·6

The effects produced, and their cost, were quite comparable with those given by solenoids of the same dimensions, and the expenditure of energy necessary to support 1 kilogrammetre was much smaller than with our former arrangement.

The problem which we took in hand is therefore solved, thanks to the assistance of M. Marcel Deprez.

We have thereupon entered jointly upon the study of a dynamo machine, for a special purpose, which we shall describe at an early opportunity.

THE INSTITUTE OF PATENT AGENTS.

We have received a copy of the second annual report of the council of this Institute, which was incorporated in 1882. The council record with gratification the steady progress made by the Institute during the past year.

The Institute now comprises fifty-four fellows, two associates, thirty foreign members, and three graduates.

During the 12 months ending April 30th, 1884, the Institute held nine meetings, and the following papers were read and discussed:—"The Patent Agent and his Profession," by Mr. Newton; on "Foreign Patents," by Mr. O. Imray; on "Some Points Regarding United States Patents," by Mr. P. M. Justice; on "The Patents, Designs, and Trade Mark Rules," by Mr. J. C. Mewburn; on "The Patent Office Library," by Mr. P. Jensen; and on "Free Trade in Patents, or some Proposed Changes in the United States' Patent Law," by Mr. E. Morton Daniel.

One of the chief objects of the Institute has been fully attained. That object is stated in paragraph 3 of the memorandum of association, in the following terms:—"To extend their opportunities and facilities for meeting, correspondence, discussion, and interchanging ideas respecting matters connected with their professional practice, and generally to aid in the acquisition and dissemination of knowledge appertaining to their profession."

The second object of the Institute is stated in the same document to be:—"To form a representative body of the patent agents of the United Kingdom for the purpose of promoting improvements in the Patent Laws, and in the regulations under which they are administered."

The council congratulate the members on the most complete and successful attainment of this object. The Institute had been already established, on a firm and broad basis, when the whole subject of the laws relating to patents, designs, and trade marks was brought before the House of Commons by a Government Bill presented by the President of the Board of Trade.

The attention of the council having been drawn by the vice-president to the fact that certain countries, not including Great Britain, had entered into a convention by which mutual privileges of great importance had been obtained by inventors belonging to those countries, a correspondence on this subject has been carried on between the Institute and the Board of Trade. It appears that Great Britain has agreed to become a party to the convention which was entered into between Belgium, Brazil, Spain, France, Guatemala, Italy, Holland, Portugal, Salvador, Servia, and Switzerland on the 20th March, 1883, and that arrangements have been made for signing the convention on behalf of this country on the 31st of May, 1884. The principal objects attained by this convention are as follow:—

1. The subjects of each of the subscribing States shall in all the other States, as regards patents, enjoy the advantages that their respective laws grant to their own subjects. 2. Any person who has duly registered an application for a patent in any one of the States shall enjoy a right of priority protecting the first patentee against any acts accomplished in the interval for a term of six months, a month longer being allowed for countries beyond the sea. 3. The introduction by the patentee, into the country where the patent has been granted, of objects manufactured in any of the other states shall not entail forfeiture; but the patentee remains bound to work his patent in conformity with the laws of the country into which he introduces the patented objects. 4. The States agree to grant temporary protection to patentable inventions for articles appearing at officially recognised International Exhibitions.

It is understood that Holland and Switzerland, where there are at present no patent laws, will shortly adopt measures, in pursuance of the terms of this convention, whereby inventions may be protected.

At one of their recent meetings the council decided on the expediency of making, for the use of members of the Institute, and of renewing from time to time, a complete collection of the patents, designs, and trade mark laws of all foreign countries and British colonies. To carry out this important and extensive undertaking the council appointed a committee of fellows, consisting of Messrs. W. Clark, G. G. M. Hardingham, O. Imray, and P. M. Justice, and empowered them to issue, in the name of the council, such circulars, to be signed by the secretary, as they may find necessary in carrying out their task.

The council heartily congratulates the members on the fact that the Institute has now attained a position which has met with full recognition from the Board of Trade, and from the officials engaged in the administration of the Patent Law.

On these grounds the council now feel justified in inviting the co-operation, as associates, of both classes of members of the legal profession, as well as of engineers, manufacturers, chemists, and others interested in the Patent Laws, and generally in the protection of inventions.

The council submitted to the ordinary meeting, held on May 4th, 1884, the following list of fellows for election as president and vice-president, and to fill the vacancies in the council during the ensuing year:—President, John Imray, M.A. Vice-President, William Carpmael. Other members of council: Charles Denton Abel, Arthur Carpmael, George Davies, William Edward Gedge, Peter Jensen, John Thompson King, John Clayton Mewburn, and William Lloyd Wise.

THE TANGENT-GALVANOMETER AS AN AMPÈRE-METER.

By J. KESSLER.

(*Concluded from page 523.*)

As the tangents of the angles of deviation if multiplied by 10 give the strength of the current in ampères, as in the following diagram (fig. 5), which, together with the accompanying table, may suffice for the ordinary gauging of practical instruments.

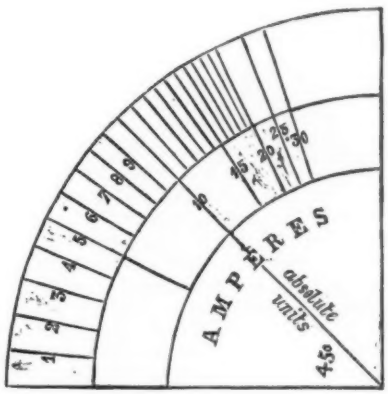


Fig. 5.

5¾°	... ...	1 A	31°	... ...	6 A
11¼°	... ...	2 „	35°	... ...	7 „
16¾°	... ...	3 „	38½°	... ...	8 „
21½°	... ...	4 „	42°	... ...	9 „
26½°	... ...	5 „			

45° 10 Ampères, or the absolute current-unit.

47½°	... ...	11 A	58°	... ...	16 A
50½°	... ...	12 „	59½°	... ...	17 „
52½°	... ...	13 „	61°	... ...	18 „
54½°	... ...	14 „	62½°	... ...	19 „
56½°	... ...	15 „	63¾°	... ...	20 „

68½°	...	...	...	25 A
71½°	...	...	...	30 „

Factor for the Reduction of any Weber's Galvanometer whatever.

Naturally any given tangent-galvanometer can be used as an ampèremeter if the factor is known for its reduction to one which shows 1 ampère.

For all tangent-galvanometers constructed on Weber's

principle, formula IV. holds good for the strength of the current :

$$i = \frac{r\,h}{2\,\pi\,n} \text{ tang. } \phi \text{ absolute units.}$$

$$\text{for 1 ampère} = \frac{\text{R H}}{2\,\pi\cdot 10} \text{ tang. } 45 = \tfrac{1}{10} \text{ absolute unit;}$$

$$\frac{i}{1 \text{ amp.}} = \frac{r\,h\,10}{2\,\pi\,n} \text{ tang. } \phi,$$

$$i = \frac{r\,h\,10}{2\,\pi\,n} \text{ tang. } \phi \text{ ampère.}$$

The reduction factor of a tangent-galvanometer with n coils and a radius of r centimetres, at a place where the horizontal component of the terrestrial magnetism has the value h in centimetregrammes, or dynes is

$$\frac{r\,h\,10}{2\,\pi\,n}.$$

As the simplest special case for the above-described tangent-galvanometer with one coil, giving the absolute current-unit at a deviation of 45°, we have, since $r\,h$ was chosen $= 2\,\pi$ (which will hold good for the next four years in Vienna),

$$\frac{r\,h\cdot 10}{2\,\pi\cdot n} = \frac{2\,\pi\cdot 10}{2\,\pi} = 10.$$

As a further example may serve the alteration of the reduction-factor for the same tangent-galvanometer after the lapse of the next four years, when

$$r = 30{\cdot}208 \text{ centimetres,}$$

$$h = 0{\cdot}209 \text{ dynes.}$$

$$\frac{r\,h\cdot 10}{2\,\pi\,n} = \frac{30{\cdot}208 \times 0{\cdot}209 \times 10}{2 \times 3{\cdot}1416} = 10{\cdot}05.$$

After the lapse of the next four years the reduction-factor will therefore increase by half per cent., which, in practical determinations will be scarcely appreciable.

Experiments with the Tangent-Galvanometer.

There follow now the results of certain experiments with the tangent-galvanometer just described. These experiments have been conducted with regard to the hints given by Prof. Kohlrausch on practical measurements.

In these experiments the tangent-galvanometer was placed at a considerable distance from even small portions of iron. It was fixed upon a wooden frame, protected as far as possible from agitation, and secured to a main wall of the house. It was connected with the battery by means of a couple of wires of 4 metres in length, twisted in the form of a cable, each wire being 2·7 millimetres in thickness, and the resistance not quite 0·03 ohm. The resistance of the tangent-galvanometer itself does not exceed 0·001 ohm.

In order to avoid the error of an incorrect orientation the current has been commuted for each of the experiments given, after the tangent-galvanometer had been placed so that in great deviations the angles at both sides did not differ by quite $\frac{1}{4}°$.

As to errors in reading off, it may be mentioned that in about 300 experiments which were made in compiling the table, owing to the size of the graduation the error probably never reached 0·2°.

The needle was exceedingly sensitive in consequence of its being suspended from a cocoon thread.

A further source of error as regards the length of the needle was quite avoided. The magnetic needle was 4 centimetres in length, or only $\frac{1}{15}$ of the diameter of the circuit (60·4 centimetres) whilst Prof. Kohlrausch finds that a correction is not required unless this proportion amounts to $\frac{1}{12}$.

The following table, with the appended remarks, gives examples for the measurement of currents, and furnishes a tolerably complete view of the strength of the current in batteries, &c.

TABLE OF DETERMINATIONS OF THE STRENGTH OF CURRENTS.

	Source of Current.	Angle of Deviation	Ampères.	Calculated. Volt.	Calculated. Ohm.	Remarks.
Daniell's Elements.	1 element -	14°	2·50	—	—	Recently charged. 10 per cent. mixture of sulphuric acid and water, 20 cm. deep. Diaphragm of white clay, 2–3 mm. thick, and previously moistened with acid.
	2 elements in quantity -	24½°	4·55	—	—	
	2 elements in tension - -	14°	2·50	—	—	
	4 elements in tension - -	11¼°	2·00	4·16	2·08	Short circuited.
	Ditto	8°	1·40	4·16	3·08	With a nickel silver wire of 1 ohm resistance.
	10 elements in tension - -	7⅛°	1·26	11·0	8·8	After being used for 10 hours with a nickel silver wire of 1 ohm.
	Ditto	8°	1·40	11·0	7·8	Short circuited; calculated volts agree with observations with Fein's voltameter.
	10 elements -	17¾°	3·21	2·08	0·65	Short circuited after four days' use.
	1, 2, 3, 4, 5, 6, 7, 8, 9, 10 -	10¼°	1·81	2·08	1·15	½ ohm introduced.
	Both groups in tension -	7⅛°	1·26	2·08	1·65	1 ohm introduced.
Bunsen Elements.	1 element -	44⅕°	9·70	—	—	Recently charged. 10 per cent. mixture of sulphuric acid and water, 20 centimetres in depth. Nitric acid, sp. gr. 1·310. Cells as above.
	2 elements in tension - -	45½°	10·5	—	—	
	2 elements in quantity -	61°	18·0	—	—	
	5 elements in tension - -	49¼°	11·7	9·0	0·80	Short circuited.
		26⅕°	4·90	9·0	1·80	With nickel silver wire, 1 ohm.
		45°	10·00	9·0	0·90	After being in use for 4 hours.

The experiments with Smee elements showed such fluctuations that the idea of tabulating them may be abandoned ; five to eight elements connected in tension gave, when short circuited, about 10 ampères.

Experiments have also been made with the tangent-galvanometer on small dynamo machines, worked by hand. As regards the inequality of such working, the fluctuations in the strength of the current are not unimportant. It may, however, be mentioned that they can be very readily observed with this galvanometer, as they range between 10 and 20 ampères. The Fein's machine and the Kröttlinger hand machine have been examined.

In case of accumulators the deviation with a short circuit is very violent, but is considerably moderated by the introduction of a resistance of 1 ohm, so that a strength of current of 1—2 ampères remains tolerably constant for about a quarter of an hour. In these experiments a Plante and a Kröttlinger accumulator of 2·5 kilos. in weight were used.

The tangent-galvanometer is in general well adapted for the study of fluctuations in the strength of the current, since, on the one hand, as the resistance is vanishingly small, the strength of the current can be observed on introducing all possible resistances, and, on the other hand, the fluctuations with the same resistance are always plain to the eye, so that in every moment the relations of the strength of the current are detected, which is not the case in the chemical measurement.

Lastly, must be mentioned the valuable remark of Prof. Kohlrausch on the use of one and the same galvanometer in measuring even the strongest currents—above 200 ampères—by the aid of the law of divided currents, as is very clearly expounded in the Berlin *Electrotechnische Zeitschrift* for 1884, to which the reader is referred.

For the relations of the strengths of currents in common practice, those especially which occur in school experiments, the tangent-galvanometer of the dimensions given above is amply sufficient for executing determinations in which the error of observation is

within one per cent. In any case, the importance of the tangent-galvanometer for measuring instruments for technical purposes is not to be undervalued, since the silver voltameter can compete with it neither in convenience, in cost, nor in accuracy.—*Zeitschrift für Electrotechnik.*

THE ELECTROMOTIVE FORCE OF THE LALANDE-CHAPERON BATTERY.

WE have on several occasions given very full and illustrated descriptions of the Lalande-Chaperon battery which has recently been brought forward in this country. Indeed, we have kept our readers fully informed on all points concerning this element from the time of its first appearance, including the tests made by M. Hospitalier. Dr. E. Van der Ven now comes forward in our French contemporary, *La Lumière Electrique*, with the results of his researches on the electromotive force of the couple. This gentleman proceeds as follows :—

Having, for a special purpose, to make use of a battery of great constancy and of a considerable yield, which, moreover, must not give off injurious gases, my attention was drawn to the element of Lalande and Chaperon. Before making use of it, however, I judged it prudent to examine its qualities myself. The results of this examination appear to me sufficiently interesting to merit publication for the benefit of those who have not the time or the appliances necessary for an investigation which, by reason of the very nature of this new element with a solid depolariser, requires much circumspection.

To avoid the errors inherent in the determination of the intensity of the current by means of electrolysis, and still more in the direct measurement of the internal resistance of a couple, I endeavoured to determine at once the electromotive force and the resistance by applying the modification introduced by M. Paalzow (*Berliner Akademie*, 1862, p. 707) in the compensation method of M. du Bois-Reymond (*Poggendorff's Annalen*, LIV., p. 161). This method does not differ from that of Poggendorff (*Annalen*, CXXXV., p. 326), save that in it we proceed in such a manner that in the expression

$$E_2 = \frac{r}{r + r_1} E_1$$

—a formula in which E_1 is the electromotive force of a standard element, E_2 being that of the given element, r the resistance which must be introduced to obtain the compensation, r_1 that of the standard element and of the necessary circuit—the variations of r may be equal and of an opposite sign to those of r_1, so that $r + r_1$ is constant during the compensation.

The electromotive force E_1 being that of two Bunsen elements, placed in series, whilst the greater part of $r + r_1$ was formed of platinum wire, graduated into 300 equal degrees, of a Siemens and Halske's universal galvanometer fitted with a vernier, which rendered it possible to read off the tenths of a degree with sufficient exactness. We have then :

$$(1) \qquad E_2 = \frac{r}{300 + x} E_1$$

where x is the sum of the internal resistance of the Bunsen battery and of that of the necessary circuit.

To avoid the direct determination of x, I have also compared the electromotive force of a Daniell's element with that of the Bunsens. I found :

$$D = \frac{r'}{300 + x} E_1$$

whence we conclude is connection with the equation (1).

$$(2) \qquad E_2 = \frac{r}{r_1} D,$$

Yet the value, E_2, which we have determined according to this equation, is not that of the electromotive force properly speaking of the couple traversed by the current ; it is the value of the difference of potentials of its electrodes. We see that in applying the method of compensation we must modify r so as to reduce to zero the intensity of the current which passes by the circuit A K_2 Z_2 G B, and we obtain this object at the moment when the astatic needle G invariably indicates zero. But we cannot reach it in the case when the two opposite currents traverse a couple of the nature of Lalande's element, because, from the moment when, by reason of a too great modification (however trifling) of r the intensity of the current E_1 surpasses that of the current E_2, the electromotive force of this latter is re-established in such a way as to turn the needle from the opposite side. If even in the circuit A K_2 Z_2 G B the intensity of the current is null for a moment, the depolarising action of the oxide of copper is strong enough to prevent the needle from remaining at rest.

Therefore, following the indications of M. Paalzow, I connected the electrodes by the circuit of known resistance E_2 G G Z_2, which contained the Gaugain galvanometer G G. Modifying them r = A B so as to render the difference of the potentials (which at A and B results from the action of the element E) equal and of contrary sign to that produced at these points by the battery E_1, no current will pass by the branches A K_2 and B G Z_2 in which the potential will be constant. The potentials at K_2 and Z_2 will be equal to those of the points A and B, the difference of which is given by the equation (1). As, on acting thus, the greater portion of the current, during the compensation, continues to traverse the circuit K_2 G G Z_2, the electromotive force during this operation will not undergo the abrupt variations which result from the depolarisation of the surface of the zinc in the element not traversed by the current.

It is evident that the difference of potentials, E_2, being given we may deduce from it the electromotive force of the element traversed by the current by means of the equation—

$$(3) \qquad E_3 = \frac{l + \eta}{l} E_2 = \frac{l + \eta}{l} \frac{r}{r'} D,$$

— l being the given resistance of the circuit, K_2, G G Z_2— as soon as the internal resistance, η, of the element is known.

We determine it by inserting between K_2 and the point of junction of the wires A K_2 in G G K_2, a known resistance C K_2 = l'. On compensating, then, the differences of the potentials at A and B, we determine that of the points Z_2 and C, since the potential is constant in the branches, A C and A B C_1 Z_2, as soon as compensation is effected. This difference will be given by the equation—

$$(4) \qquad E'_2 = \frac{r_2}{r'} D$$

if r_2 represents the number of parts of platinum wire which must be introduced into the circuit to effect the compensation.

We obtain in this manner a second equation :—

$$(5) \qquad E_3 = \frac{l + l' + \eta}{l} E'_2 = \frac{l + l' + \eta}{l} \frac{r_2}{r'} D$$

Whence we infer, in conjunction with the equation (3),—

$$(6) \qquad E_3 = \frac{r\, r_2}{r' (r - r_2)} \frac{l'}{l} D,$$

$$(7) \qquad \eta = \frac{r_2}{r - r_2} l_1 - l.$$

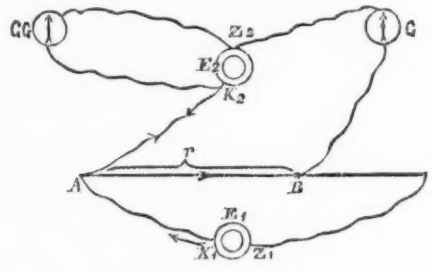
The plate of zinc weighed 2·92 kilos. Its dimensions were :—length, 40 centimetres ; width, 18 centimetres ; thickness, 4 millimetres. After the experiments it weighed 1·90 kilos.

The element contained a solution of 0·9 kilo. of caustic potash in three litres of water and 0·9 kilo. oxide of copper.

We found:—

	The Circuit Closed during	E_2 Mean result of seven observations.	E'_2 Mean result of seven observations.
1st day	7 hours	0·54 D	0·32 D
2nd day	7 „	0·47 D	0·29 D
3rd day	7 „	0·43 D	0·27 D
4th day	7 „	0·45 D	0·28 D
5th day	7 „	0·36 D	0·24 D
6th day	7 „	0·26 D	0·22 D
7th day	7 „	0·23 D	0·19 D

The unit D, in which the values E_2 and E'_2 are expressed is not a constant quantity. Still I have taken care to renew the Daniell element daily, and to place the cylinder of zinc in pure water during the intervals of two consecutive observations.



We see already, by inspecting the values E_2 and E'_2 that the electromotive E_3 of the element must have been approximately constant during the first four days. We observe, however, that this favourable result must be partly attributed to the fact that during this time the current has been closed only during seven hours daily, and that to conclude from this fact that the element is constant for 28 successive hours would be premature. The depolarising action of the oxide of copper is such during the intervals of rest that each morning, at the beginning of the experiments the intensity of the current was superior to what the element had produced on the first day. The observation-sheet shows that for these consecutive days the Gaugain galvanometer indicated respectively the deviations 29°, 28°, 25°, 24°, 23°, and 22° at the moment of closing the current.

I have not been able to measure at these moments the difference of potentials of the electrodes, it diminished for more than half-an-hour which prevented the compensation.

The resistances l and l' were measured by means of the universal galvanometer. Taking 0·1 S.U. as comparative resistance, I found as the mean of six observations

$$l = 0{\cdot}210 \text{ S.U.} = 0{\cdot}20 \text{ ohm.}$$
$$l' = 0{\cdot}181 \text{ S.U.} = 0{\cdot}17 \text{ ohm.}$$

On substituting these values and those of E_2 in the equations (6) and (7) we find, for the mean value of the electromotive force and of the internal resistance of the element during the first four days:

1st day	$E_3 = 0{\cdot}668$ D	$\eta = 0{\cdot}05$ ohm.
2nd day	$= 0{\cdot}664$ D	$= 0{\cdot}08$ „
3rd day	$= 0{\cdot}623$ D	$= 0{\cdot}09$ „
4th day	$= 0{\cdot}645$ D	$= 0{\cdot}09$ „

It follows that if we take D = 1·026 volts, the mean value of the electromotive force during the period of constancy is 0·66 volts and that of the internal resistance 0·075 ohm, so that in a circuit the external resistance of which is equal to the internal resistance, the element produces a current of 4·4 ampères. This considerable production of electricity, which results exclusively from its low internal resistance, is one of the characteristic attributes of this new element with a solid depolariser.

It is evident that it cannot be used for purposes which require a great difference of potential between the different parts of the circuit. Thus, *e.g.*, it follows that an Edison lamp (with a resistance of 54·2, I = 0·9) would require a battery of about 82 elements in series to illuminate with an intensity of 13 candles. In the same manner a Swan lamp (resistance 35·8; I = 1·2) would require 74; a Maxim lamp (resistance 26·7; I = 1·4) about 70, and a Lane-Fox lamp (resistance 24·4); I = 1·5) about 67.

We may observe lastly, that the decrease of the differences of potentials E_2 and E'_2 during the three last days of the experiments, results solely *from an increase of the internal resistance of the element and not from a decrease of the electromotive force.*

This results from the fact that the ratio $E_2 : E'_2$ approaches more and more nearly to unity as the absolute values of E_2 and E'_2 decrease, for it is plain that the ratio

$$\frac{E_2}{E'_2} = 1 + \frac{l'}{l + \eta}$$ only approaches unity as the value of η increases.

Thus, if we substitute the means of E_2 and E'_2, observed during the three last days in the equations (3) and (5) we have

$$E_3 = 0{\cdot}64 \text{ D} \qquad \eta = 0{\cdot}16$$
$$E_3 = 0{\cdot}69 \text{ D} \qquad \eta = 0{\cdot}28$$
$$E_3 = 0{\cdot}68 \text{ D} \qquad \eta = 0{\cdot}38$$

To what cause must this increase of the resistance be attributed? I see the probable cause in the badly-conducting stratum of hydrate of copper (Cu O, Ho) which is deposited on the parchment-paper by which the plate of zinc is separated from the oxide of copper. It follows then from the fact—that during the three first hours of renewed activity each day the resistance is less than at the end of the experiments of the former day—that this layer has been partially reduced during the time of rest. This layer will be formed so much the more easily as the solution contains less of free alkali.

As for the intensities of the current, considerable but rapidly diminishing which we observed at the beginning of each series, they must be exclusively attributed to a real increase of the electromotive force, an augmentation which results from the action exerted by the oxide during the rest of the element upon the layer of hydrogen, which is never instantaneously oxidised while the element is in action. These intensities, it is true, relate to an electromotive force much superior to that of the element in action. But it must not be forgotten that according to the researches of Poggendorff (*Annalen*, CLXX., p. 60), the initial force of the inconstant element, zinc-potassa, will have a value of 1·003 D, and that I have myself observed during these periods of rapid decrease values of r, which would lead to a value $E_2 = 0{\cdot}75$ D.

Submarine Telegraph Cable between Japan and the Korea.—The Japanese Government has given notice that a submarine telegraph cable has been laid in Korea Strait from Kotomura (lat. 33° 32¾′ N., long. 129° 55½′ E.), north-west coast of Kiusiu, Japan, to Tsan-liang-hai (Fusan or Chosan harbour), south-east coast of the Korea. The cable is landed at intermediate stations on Ika Sima and Tsu Sima. From Kotomura it is laid between Kagara Sima and Oögowa Sima to the eastern shore of Go no Ura (Gonolbra) Iki Sima, thence to Itsuhara harbour, on the east coast of Tsu Sima, and finally from Komada (Komotamura), on the west coast of Tsu Sima, to the Japanese station at Fusan. In the inner part of Fusan harbour the cable is marked by buoys. Mariners are informed that anchorage in the vicinity of this cable is prohibited.

NOTES.

Electric Lighting.—We learn that Mr. W. F. Thomas has just completed arrangements with the Maxim-Weston Electric Light Company for the lighting of Covent Garden Theatre and the Floral Hall during the forthcoming season of promenade concerts.

Arrangements are being made, we understand, for fitting up the turret at the Admiralty Pier, Dover, with the electric light. A pair of new engines and dynamo machines are to be placed in the engine chamber of the turret for this purpose.

It is said that the municipal authorities of Munich are in treaty with Mr. Schuckert, of Nürnberg, for the lighting of several streets in their town.

On Thursday last week Lord Greville asked, in the House of Lords, whether any steps were about to be taken as to the lighting of the House by electric light; also, having in view the very great importance of obtaining the best and most economical results, whether Her Majesty's Government would ask the leading companies in Great Britain to tender for the same. Lord Sudeley said he was unable to say exactly when the House and libraries would be lit up by the electric light, but the First Commissioner of Works had the lighting of both Houses under his consideration. As a considerable amount of money would have to be expended the plans connected with it naturally required most careful looking into; and as a portion of the work had been carried out by one company, the First Commissioner was unable to say, to what extent it would be possible to invite public competition, but he hoped he might be able to do so.

The activity manifested at the Forth Bridge Works, gives, says the *Edinburgh Daily Review*, promise of considerable progress being made before the winter sets in. There are now over 1200 men employed in connection with the undertaking, aided by some 40 steam-engines of various powers, and work is carried on day and night, the electric light being a great aid during the night.

At the meeting of the Greenock Water Trust last week the minutes of 6th June, which were read, contained the following: "The superintendent reported that an application had been made to him by the Police Board, as Local Authority under the Greenock Electric Lighting Order, 1883, regarding the supply of water for power to drive the electric lighting machinery proposed to be fitted up at Prospect Hill for experimental purposes. The superintendent stated that 25 horse-power could be given night and day. The committee agreed to give the water power to the Police Board free of cost for the first year, the Board being at the expense of fitting up the turbine and making the connections thereto. The motion was agreed to."

The International Forestry Exhibition, which is to be opened at Edinburgh on the 1st July, is to be lighted in the evenings by means of electricity, the arc light being the system employed. The lamps will be hung on lofty poles outside for the lighting of the grounds. One of the attractions of the Exhibition will be an electrical railway 700 feet in length, which is to be laid down on the north side of the Exhibition buildings.

The Edison and Swan Company desires to direct attention to its latest prices and particulars of the new and improved type of Edison dynamos.

Mr. J. S. Watson, superintendent of the Cunard Steamship line, says:—"We now have electric lights, three different kinds, in the *Servia*, *Aurania*, *Pavonia*, *Cephalonia*, *Bothnia*, and *Gallia*, and we have every reason to be entirely satisfied with them. All new steamships will be furnished with them. They are economical, give a better light than gas or oil, and, best of all, give out no heat."

The Bridgeport (Conn.) Electric Light Company have increased their plant of Thomson-Houston arc lights to a full hundred. This light, states the New York *Electrical World*, is gaining a very strong hold on the affections of the New Englanders.

At the Stockton Theatre Royal the Gilbert-Sullivan production, "Iolanthe," has been performed during the week, an electric "star" light being introduced as an ornament for the principal performer's hair. This has been effected by Mr. Goldston, of the Hammond Electric Light Company, Middlesboro'.

Mr. Gilman, the managing director of the Gülcher Electric Light Company, writes to us as follows, in reference to a note in our last week's columns:—"The accident at the Crystal Palace, referred to in your last number, resulted from the bursting of some cotton belting, which has since been replaced by a leather band. Electrically, we venture to think that the Crystal Palace installation is a great and complete success."

The Post Office and the Telephone Companies.—The following letter, signed "Shareholder," appeared in the *Times* of Tuesday last:—"A good deal has been written lately about the action of the Post Office in controlling the development of the telephone system, but I fancy the real secret of the policy of the department has not yet been openly disclosed. It is well known that under the Telegraph Acts the Post Office possesses a monopoly of both the telegraph and telephone systems, but it is not so well known that the monopoly in regard to telephones is interfered with by the United Telephone Company, who possess in regard to certain instruments patent rights which do not expire for some six or seven years. At the end, therefore, of some six or seven years, if no better instruments are discovered before that time, the patent rights of the United Company will lapse, and the Post Office will then acquire the free and unfettered use of whatsoever instruments it may choose. The control of the Post Office is now only relative, it will then be absolute and indisputable. Not being above having an eye to the interest of the department, the Postmaster-General thinks, I fancy, that by adopting 'a waiting policy' he will acquire the reversion without cost, and thus do a good stroke of business for the department and the country. How far this policy is defensible or how far it will be sanctioned, is another matter. In the interest of social progress and scientific advancement it is to be regretted that the Post Office was ever able to establish its claim to the telephone, but, this claim being established, the public have a right to expect—department or no department—that no unnecessary obstacles shall be thrown in the way of its development."

In the House of Commons on Tuesday, in answer to Mr. Arnold, who made various inquiries on behalf of Mr. Slagg, as to the arrangements between the Post Office and the telephone companies, Mr. Fawcett said: To reply to the series of questions addressed to me by my hon. friend would involve so many complicated details that I could not properly answer them without unduly encroaching on the time of the House. I am about to make a proposal which I hope will be thought fair and reasonable. I am frequently asked by the various telephone companies to modify in different respects the existing terms on which they carry on business. I am, therefore, about to propose that the telephone companies should meet and endeavour to come to an agreement as to the modifications of those terms which, in their opinion, would meet the public requirements. Should they act upon this suggestion and communicate the result to me in writing, their proposals shall at once be carefully considered with every desire to allow the greatest freedom possible to telephonic communication which is compatible with due protection of the interests of the revenue.

The Telephone in Melbourne, Australia.—The present number of subscribers to the exchange in Melbourne is 730, and is constantly increasing. The central office has been found too small for the business which

has to be done, and removal has become necessary. An entirely new building has been built in William Street, and is now occupied. Improved switching apparatus is to be employed from the manufactory of the Western Electric Company of Chicago; and Mr. James C. Warner, electrician to the Western Company, was engaged by the Melbourne Telephone Exchange Company to fit up the new premises.

Telephoning from Moving Trains.—Mark F. Parish and S. J. Munn, of Niles, Mich., are stated to have nearly perfected an electrical railway signal, by which a collision between trains will be rendered absolutely impossible, by operating a telephone between trains of the same circuit; the instant another train comes on, the circuit is formed, and the bell in the cab of each engine will ring.

Telegraphic.—A *Times* telegram from Hongkong states that a Chinese line of telegraph has been constructed and is now working between Canton and Lungchou (90 miles south of Nanning) on the Tonquinese frontier.

Destructive floods have occurred in Galicia, and telegraphic intercourse is more or less interrupted.

Bourton post-office, near Bristol, has been opened as a postal telegraph office.

Telegraphic Reforms.—At a meeting of the Birmingham Chamber of Commerce last week, resolutions were passed to memorialise the Postmaster-General and the Chancellor of the Exchequer upon the subject of postal and telegraphic reforms. The chamber expressed its regret at the proposed delay in the introduction of sixpenny telegrams, remarking that lower rates than at present exist are prevalent in nearly all European States, and that such excess of the British rate constitutes a factor to the detriment of the latter in competition with foreign countries. Further points dilated upon were that whilst the Treasury was in possession of a postal surplus of £3,000,000 per annum, it appeared incongruous to delay the adoption of a new service which must prove a great convenience to trade and to the public, because of a temporary loss so small as that (£180,000) which has occurred in the parcel post service; that the introduction of sixpenny telegrams would probably have produced a surplus which would have compensated for the loss on the parcel post; and that the proposed delay of the introduction of this reform for financial reasons shows the prejudicial effect of the practice which has led to the appropriation by the Treasury of almost the entire postal service.

The Telegraphic Arrangements in the late Egyptian Campaign.—The Select Committee appointed to enquire into the way in which the transport and commissariat departments of the British army were conducted during the recent campaign in Egypt sat last week, when evidence was given by Colonel Salmond, R.E., who stated that the telegraph corps connected with the Engineers ordered out to Egypt did not arrive until a week after the whole of the troops were in that country. During that week there had been advances as far as Kassassin, and four engagements had been fought. In the meantime, he (the witness) had charge of the telegraphic arrangements and had great difficulty in obtaining operators; some of the men could only work the single needle instrument. The Arabs had cut the wires in innumerable places, and the way in which they were repaired was as follows:—There was a detachment of the 8th company sent out to repair the railway, and he gave to the officer in charge a telegraphic instrument and a man to work it, and also sent out an Arab lineman he found in Ismailia. Dr. Cameron: How did you ascertain his qualification? Colonel Salmond: By signs. I took a piece of wire and a piece of copper and pointed to the ground, and he understood what it meant when I placed two pieces of wire together; he understood he had to join them. This man was able to reunite the wires, and it was owing to his services that telegraphic communication was kept up until the arrival of the Engineers.

The Bennett-Mackay Cable.—An American contemporary has the following:—"The New York *Herald* people now positively state that their first cable will be completed and in good working order by the middle of July, and they just as positively assert that they will give the public the universal rate of threepence a word on all messages, notwithstanding the threats of the cable pool to cut below a living rate. Preference will be given to full-rate messages in the order of their filing. Outside press messages, that is, press messages other than those addressed to the New York *Herald*, will come next, and will probably be carried at some reduction from the full rate. Dispatches filed for the *Herald*, excepting possibly those of an urgent character, will then be transmitted, taking the third or last place in the order of precedence. In other words, the *Herald* proposes to utilise the cable when everything else is clear to its fullest extent. They will see that the wire shall not know an idle moment. Their operators will work night and day, unceasingly, and when the revenue from outside sources lets up, for no matter how short a time, the *Herald* will jump in and derive all the benefit it can from what would, under ordinary circumstances, be a dead loss."

It is a singular coincidence, whether significant of the future of the enterprise or not, remarks the Boston *Herald*, that the first successful step in the Bennett-Mackay, or Commercial Cable, enterprise comes on the 41st anniversary of the first practical demonstration of the possibility of the electric telegraph.

The s.s. "Faraday."—This cable ship left the River Thames on Monday last for Valentia, Ireland, where she will land the shore end of the Mackay-Bennett cable; from thence she will proceed submerging the deep sea portion towards the buoyed end off the Flemish Cap. The *Faraday* passed the Lizard on Wednesday afternoon. All well.

Telegraph Clerks and Sunday Work.—A large number of the Edinburgh telegraph clerks met on Saturday evening in the Café Royal to confer with regard to Sunday labour. Before the meeting closed the following resolution was adopted:—Resolved, that this meeting memorialise the Postmaster-General on the subject of Sunday labour in the telegraph service. While recognising the fact that Sunday labour is now to some extent a public necessity, it would be grateful to him for any effort he may make with the view of minimising such duty as much as possible, but urges that it should be performed in all offices under similar conditions, and that employés in the provinces should no longer be called upon to perform this exceptional duty under conditions other than those in force at the Central Telegraph Office in London—viz., payment as overtime for all duty performed on Sunday.

An Edinburgh contemporary writes:—The telegraph clerks in Edinburgh, as elsewhere throughout the provinces, have a grievance. The complaint they make is no trumped-up nor fanciful affair. The hardship they allege is genuine. Called to do extra work on Sundays, they get no extra pay: whereas their fellows in London, where the labour is kept down to a minimum, are rewarded for whatever they are asked to do. Mr. Fawcett says that according to the Post Office rules, Sunday work is not exceptional. The Postmaster General is a consummate logician; but he will find it hard to square his reasoning with his facts. The London case goes dead against him, and the complainers have not been restrained by gallantry from citing another instance it is alike impossible to explain away. If the rules recognise no exceptions, how is it that the female clerks are left to the enjoyment of their Sunday rest? The questioners mean to press for a reply. They are entitled to get one—in the shape of a promise that Sunday work will be kept down as far as possible, and its performance be paid for as overtime. Stingi-

ness towards such a class of public servants is never politic, and seldom profitable.

Gas Engines and Electric Lighting.—Sufficient experience, says the *Leeds Express* of the 20th inst., has now been gained of the lighting by electricity of a portion of the Leeds new municipal buildings in Calverley Street to place its success beyond doubt. This result is the more gratifying, inasmuch as the employment of gas engines in driving the dynamo machines which generate the electric current was, for long, the subject of strong opposition, and it was only by prolonged and persistent investigation, and after much trouble that those who pinned their faith to gas engines secured their adoption. The employment of steam engines and boilers would be inconvenient and expensive, while the cost of conveying the power from an out-building to the place intended to be lighted would not only have been considerable, but in transmission a serious proportion of the power would be lost. Thus, it was calculated that, supposing the copper in the mains for conducting the power cost £1 per light when the lamps were distant two hundred yards from the engine, it would cost £4 per light if they were distant four hundred yards; while there would be a constant loss in the conducting wires equal to about ten per cent. of the total power. Some members of the Corporation Committee, however, held that the makers of the "Otto" gas engines had now reached a point in their manufacture which did away with the risks and disadvantages urged against their use for this purpose. Those who visit the new library any evening now can see in the perfectly satisfactory nature of the lighting how well grounded this belief was. So perfect is the lighting, and so well have the "leads" been arranged, that the variation of power in the light from the top to the bottom of the building—from the starting place to the furthest point to which the power is carried—does not exceed two per cent. This affords striking evidence of the skill with which the "leads" have been planned out, and of the steadiness of the engines. For the first few days of the lighting those who had predicted evil things of the gas motors found cause of complaint in a concussion produced by their working, arising from the explosion caused by the gas. This, however, was quickly remedied by the completion of the exhaust receiver—a brick enclosure filled with rubble, over-laid by a four-inch deposit of river sand; by which the noise of the explosion is rendered imperceptible. The engines are of 12 horse-power each, and are supplied from two 80-light meters.

The Drawbaugh Case.—The *Electrical Review* of New York states that the famous "Drawbaugh suit" is approaching its end. The evidence is all in, and it is said that the arguments may be looked for in July. They will be looked for with an interest only second to that which the opinion of the court will excite, for both sides have able counsel, and both have devoted unlimited time and money to the perfection of their case. As to the outcome, men differ in opinion as much as they did in the case of the great English "Claimant."

Conference of Electricians.—A bill is pending in the American House of Representatives for the appointment of a Government Commission to conduct a national conference of electricians and make special investigation on the occasion of the International Electrical Exhibition to be held in Philadelphia next September.

Underground Wires at Chicago.—The city electrician, thoroughly convinced of the efficacy of underground telegraphy, is now, states the New York *Electrical World*, superintending the placing of all the city wires underground.

Engineers and their Workmen.—The coffee palace and dining hall in connection with Messrs. Robey & Co.'s Globe Works, Lincoln, was publicly opened on Friday evening of last week. The premises occupy an area of 663 square yards, and are situated immediately opposite the main entrance to Messrs. Robey and Company's works. The building has been taken over by a Coffee Palace Company, who rent the same on favourable terms on condition that they supply cheap refreshments to the men employed at Messrs. Robey and Company's works. There are two dining-halls for the workmen—one above the other, with separate entrances to each—and together capable of accommodating 700 men, and these will be well filled at breakfast time, a lesser number of men staying to dinner. Each room has hot and cold water laid on, and convenience for securing hot meals to all workmen who choose to have them, the attendants making all necessary preparation, and placing each man's meal in its appointed place before him, so that he finds all ready on entering the dining hall. While Robey and Company employ nearly 1,200 men, about one-half of this number live in the immediate neighbourhood (a large proportion in their own houses), and do not, therefore, need any accommodation for dining at the works. This dining hall has been put up by Robey and Company in consequence of their present one proving altogether inadequate for the accommodation of their workmen.

City and Guilds of London Institute.—The following additional donations to the Equipment Fund of the Central institution have been voted in response to the appeal of the Prince of Wales:—The Goldsmiths' Company, £4,000 (subject to confirmation); the Salters' Company, £525; the Cordwainers' £250. The Plaisterers have increased their annual subscription from 50 guineas to £100. The Central Institution for the Advancement of Technical Education, situated in Exhibition Road, South Kensington, was opened by the Prince of Wales on Wednesday. In the course of the proceedings, amongst others, Prof. Ayrton, Prof. Armstrong, Prof. Henrici, and Prof. Unwin, the recently elected professors of the institution, had the honour of being presented to His Royal Highness.

Electric Systems at Philadelphia.—The City Councils of Philadelphia having appropriated $10,000 for the purpose, the city authorities are just now introducing the police, fire and telephone system which has proved so successful in Chicago. So much trouble has been caused recently by "crosses" on the fire alarm wires that the officials have notified all the companies that hereafter they must have all their wires placed at least four feet above those belonging to the city under penalty of having them cut.

Telpherage.—Replying to a correspondent, Prof. Fleeming Jenkin estimates the cost of a telpher line to convey 10 tons per hour for a distance of 1¼ miles as follows:—If the gradients are unfavourable and the load has to be worked up-hill, the first cost, including engine, boiler, shed, dynamos, countershaft, belting, line, sidings, rolling stock, royalty, freight and agency, might be about £3,000. If the gradients were favourable, and the load carried either on a level or down hill, only the empty trains running up-hill, then cost might be reduced to about £2,000.

Electrical Exhibition at Boston, U.S.A.—An exchange states that arrangements are nearly completed to hold a grand electrical exhibition in Boston in the ensuing winter. It is proposed to make the display the most complete in the field of electricity, showing not only the great inventions that are agitating the public mind from day to day, such as electric lights, telegraphs, telephones, &c., but to make it also the most exhaustive in the less-known branches, and in the thousand and one articles that owe their existence in part or wholly to developments in electrical science.

Disastrous Fire.—A fire broke out in the *Mail* building, Toronto, recently, and before it could be got under control $30,000 or $40,000 worth of damage was done, the principal sufferers being the telephone company.

Electrical Induction in Underground Conductors.—A paper was read before the Royal Society of Canada at its meeting on Wednesday afternoon, 21st May, at Ottawa, by Mr. F. N. Gisborne, Superintendent of the Dominion Government Telegraph Service. Mr. Gisborne's paper was descriptive of a new system devised by himself. Proofs of the efficiency of his system were given in the production of a tabulated statement of tests made of a section of cable over 3,000 feet in length, which was constructed under his direction, and laid between two of the departmental buildings in that city. The cable in question contains 20 insulated conductors; these are directed into 10 pairs, two conductors being twisted together in each case, each pair being utilised as a metallic circuit, one conductor being used as a return, instead of the earth, as is usual. The peculiarity of the cable consists in this twisting of the wires forming metallic circuits, in that both wires are thus made to occupy the same relative position with respect to any other conductor or pair of conductors in their neighbourhood. The philosophy of this device is, that a current passing through any such circuit has necessarily to pass down one wire and up the other, and it is evident that the positions of both with respect to a neighbouring circuit, being the same as above stated, the inductive effect of the current passing down one wire is neutralised by the inductive effect of the same current passing up the return wire. It would appear, therefore, that Mr. Gisborne's system is in reality one in which the phenomenon of current induction does not obtain rather than one by which the effects are neutralised. Considerable interest in this connection has already been manifested, and it is understood that letters patent are about to be issued in Canada and the United States to the gentleman in question.—*Canadian Electrical News.*

Compensated Resistances.—On the 28th of February Prof. George Forbes read a paper before the Society of Telegraph Engineers and Electricians on "Compensated Resistances"—that is, resistances which would remain the same however the temperature might vary. Prof. Forbes remarked:—"I think it probable that this subject has been worked out by other people, although I have not been able to come across their work, and this communication to you may cause another 'Breguet'* to announce himself." During the discussion on this paper Prof. W. E. Ayrton rose and said:—"It is a little invidious to be the 'Breguet' which Prof. Forbes said would probably turn up, and Dr. Fleming has been the Breguet. (Dr. Fleming had stated that Mr. Edison employed such a method of compensation in his electric light meter.) I would add that the plan of combining platinum and carbon is the principle of the Gatehouse incandescent lamp." Prof. Forbes: "Not in series."—Prof. Ayrton: "I think sometimes in series."—Prof. Forbes: "No." It only remains for us to add that Prof. Ayrton was correct in his statement.

Society of Arts.—The Council of the Society of Arts have awarded the society's silver medals to the following readers, amongst others, of papers during the session 1883-4:—To Prof. Fleeming Jenkin, F.R.S., for his paper on "Telpherage"; to I. Probert, for his paper on "Primary Batteries for Electric Lighting"; to Prof. Silvanus P. Thompson, for his paper on "Recent Progress in Dynamo-Electric Machinery." Thanks were voted to the following members of council for the papers read by them:—To W. H. Preece, F.R.S., vice-president of the society, for his paper on "The Progress of Electric Lighting"; to Col. Webber, R.E., C.B., member of council, for his paper on "Telegraph Tariffs."

A conversazione will be held at the International Health Exhibition by the Council of the Society of Arts, in conjunction with the Executive Council of the Exhibition, on Wednesday evening, 9th of July. The whole of the buildings will be open, and the gardens will be illuminated.

The Turin Exhibition.—At the Turin Exhibition a street railway is to run from the Piazzo Carlo Felice to the principal entrance of the building. The motive power will be supplied by electric accumulators invented by Signor Nigra.

Universal Exhibition at Antwerp.—An exhibition is announced to take place at Antwerp from May to October, 1885, under the patronage of the King of the Belgians, in which electricity is to be a prominent feature. The agent for Great Britain is Mr. T. L. Simmonds, 35, Queen Victoria Street, E.C.

Electricity and Torpedoes.—Torpedo experiments are being conducted at Bantry Bay by several vessels under the command of the Duke of Edinburgh. Recently the electric contact mines were put to a satisfactory test, when they were bumped by the ships as they passed over the torpedo field, and the rapid explosions of the gun cotton discs on shore bore testimony to the accuracy with which the mines had been laid down.

Lightning Conductors.—Mr. William G. Heys, writing to the *Manchester Guardian*, says:—"My own experience, and the evidence of competent electricians who have investigated the subject, tend to prove that only a small number of lightning conductors possess even a relative efficiency, and that the majority, from one cause or another, are not only absolutely useless, but dangerous, since their existence begets a false sense of security."

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

British Spiral Telephone Wire Syndicate, Limited.—The first return of this company, made up to the 31st ult., was filed on the 7th inst. The nominal capital is £50,000 in £5 shares; 2,794 shares (inclusive of those issued to the vendor as fully paid) have been taken up, and the full amount has been called thereon. The calls paid, and considered as paid, amount to £13,412, leaving £558 unpaid.

An agreement, dated 17th March, was filed with the documents of the company on the 23rd inst., under which Mr. Wm. Downie agrees to accept, in lieu of the sum of £10,000 cash, forming part of the purchase consideration, 10 debentures of the Syndicate for £1,000, each bearing 6 per cent. per annum interest, and redeemable as follows: three within 6 months, three within 12 months, and the remaining four within 18 months' of the date of the agreement.

Edison's Indian and Colonial Electric Company, Limited.—At an extraordinary general meeting of the members of this company, held at 4 and 6, Throgmorton Avenue, on the 28th ult., it was resolved to reduce the capital from £250,000 divided into 40,000 A and 10,000 B shares of £5 each to £117,500 divided into 45,000 A shares of £2 10s. each and 5,000 B shares of £1 each; all arrears of cumulative preferential dividend payable in respect of the original A shares attaching to the corresponding reduced and subdivided A shares. The resolutions were confirmed on the 13th inst. and registered 18th inst.

Provincial Telephone Company, Limited.—A meeting of the shareholders in this company was held on the 14th inst., when an account was laid before them showing the manner in which the winding-up of the company has been conducted, and the property of the company disposed of.

Change of Office.—The office of the Railway Electrical Contractors, Limited, is now situate at 4, Great Winchester Street, E.C.

* Prof. Forbes had completed certain experiments in telephony and then found that the work had been done previously by M. Breguet.—EDS. ELEC. REV.

CITY NOTES.

The United Telephone Company, Limited.—The directors have decided, subject to audit, and after making ample provision for depreciation, &c., to recommend at the forthcoming annual general meeting, to be held on the 8th prox., a dividend for the second half-year ending 30th of April, 1884, at the rate of 5s. 6d. per fully paid share, part paid shares receiving in proportion, making, with the interim dividend paid on the 8th of January last, a total dividend for the 12 months ending 30th of April last, of 8 per cent. per annum. The transfer books of the company will be closed until the 8th prox.

Compagnie Francaise du Télégraphe du Paris à New York.—The available balance for distribution for the year ended 31st December, 1883, after adding 208,906 frs. to the reserve, and including 43,897 frs. brought forward is 1,924,055 frs. An interim distribution of 10 frs. per share was made in January, amounting to 840,000 frs., and a similar distribution will be made on the 15th of July, a balance of 244,055 frs. being carried forward.

J. B. Rogers Electric Light and Power Company, Limited.—Creditors of this company are required on or before the 14th July next, to send their names and addresses and particulars of their claims, &c., to Mr. Frederick George Painter, official liquidator of the company, at 2, Moorgate Street Buildings, E.C.

Electric Association, Limited.—The liquidator, Mr. F. A. Ford, will lay an account of the manner in which the winding up of this company has been conducted before a meeting of the shareholders, to be held at the registered offices, Hatton Court, Threadneedle Street, on the 25th prox.

The West Coast of America Telegraph Company, Limited.—The coupons due on the 30th June next, on the debentures of this company, will be paid by Messrs. Barclay, Bevan & Co. The coupons must be left three clear days for examination.

Pilsen-Joel and General Electric Light Company, Limited.—A petition has been presented to the Court for confirmation of a resolution to reduce the capital of the company from £200,000 to £85,480.

Eastern Extension, Australasia and China Telegraph Company, Limited.—An interim dividend has been declared, for the quarter ended 31st March last, of 2s. 6d. per share.

Anglo-American Brush Electric Light Corporation, Limited.—Monday, June 30th, has been appointed a special settling day for the £5 shares with £3 paid of this corporation.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending 20th June, were £2,768, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

LEGAL.

Muirhead v. Direct United States Cable Company, Limited.—The hearing of this case, which was referred to in our Notes of the 14th inst., was resumed before Mr. Baron Huddleston in the Court of Queen's Bench, on Tuesday. It was a claim by the plaintiffs of £1,000, alleged to be due to them by the defendants in consideration of the right to use their duplex system of telegraphy. The defendant company denied their liability, alleging that the duplex system had failed to operate satisfactorily upon their cable; to which the plaintiffs replied that such failure was not in consequence of any defect in their system, but on account of a fault—a loss of insulation—which had occurred in the defendant company's cable. Reference having been made at the previous stage of the hearing of a pool agreement, by which the company received the same proportion of the joint receipts of the four companies concerned, whether their cable was in effective working order or not, Mr. Finlay, Q.C., on behalf of the company, on Tuesday, remarked that the pool arrangement was in force at the time the agreement with the plaintiffs was entered into, and the latter were aware of it. Mr. Webster, Q.C., for the plaintiffs, thereupon called Mr. John Muirhead, who stated that he was totally unaware of the agreement for pooling the receipts of the various companies at the time they made their arrangements with the company.

Mr. Herbert Taylor, of the firm of Clark, Ford and Taylor, telegraph engineers, stated that he was one of the co-patentees of the Muirhead duplex system, and one of the plaintiffs. He then proceeded to describe the various submarine cables to which the duplex system was applied, the only other Atlantic cables, however, which made use of the Muirhead system, being those of the Western Union Company, from Penzance, in Cornwall, to the United States, upon which it had worked satisfactorily for over a year; the duplex system operated satisfactorily for four years on the Direct United States cable. He (witness) was sent to Ireland to test the cables of the Direct United States Company, and of the Anglo-American Company, for the purposes of some joint purse arrangement, the details of which were not made known to him. There were over 15,000 miles of submarine cable over which the duplex system worked satisfactorily. This closed the plaintiffs' case, and Mr. Finlay contended that the evidence proved that the duplex system had failed to work upon the defendant company's cable, such cable being in effective working order for the use of the simplex system, and there being no obligation on the part of the company to incur a heavy expenditure in order to make their cable correspond with the artificial cable comprising the plaintiffs' duplex system, which was necessary for the successful application of the latter. He called

Frederick William Topping, superintendent of the Irish station of the Direct United States Company, who stated that previous to April, 1882, the duplex system worked satisfactorily, but on the 16th of that month a loss of insulation in the cable occurred, strong currents being noticeable, and from that day the duplex system would not operate. They were able to work the simplex system quite satisfactorily, and transmitted their share of the traffic. Cross-examined by Mr. Webster, witness said he remembered a fault in the cable, which was repaired by the *Faraday* in 1879, but since August, 1877, there had been no total interruption of telegraphic communication. The cable was in a perfectly satisfactory condition for simplex working, and always had been. At the time the duplex system failed, a galvanometer invented by Mr. Fuller, the secretary and traffic manager of the company, was applied, as he understood, for the purposes of trial, it being a new invention. Questioned further, and confronted by reports of tests made by himself, the witness admitted that since April, 1882, delays had been frequently occurring in the working by the simplex system, the signals being also not so distinct, and one object of the use of Mr. Fuller's galvanometer was to remedy this.

Mr. John William Fuller, secretary of the company, said his attention was called to the want of insulation in the cable in April, 1882, since which time the simplex system only had been worked. Occasional delays had occurred in the transmission of messages, but not sufficiently to materially affect the traffic; no complaints were received from the public. Two total interruptions had occurred on the main line since the cable was laid, one in 1875, about 150 miles from Torbay, in Nova Scotia, in from 100 to 200 fathoms of water; the other being on the shore in about five or six fathoms of water; the cable was picked up and repaired in each instance. There had been no fishing for leaks, as distinguished from total interruptions, since the cable had been laid. With regard to his galvanometer, he had thought of it before any fault occurred in the cable, and thought of applying it with the view of improving the signals, whether there was a fault in the cable or not. He went to Ireland on the 28th May, 1882, and found that no balance could be obtained between the real cable and the artificial one of the plaintiffs', upon the maintenance of which balance the successful application of the latter depended. He remained there until June 5th, endeavouring to restore the balance, but did not succeed. The fault in the cable was not the result of any negligence on the part of the company, and he knew of nothing that could have been done to prevent it. Baron Huddleston: Supposing the simplex system failed to act, what would you have done? Mr. Fuller: We must have repaired the cable; but as it would work, rather than incur the expense of making the duplex system act by repairing the cable, we preferred to go on with the simplex. Baron Huddleston: But if the repair were made you could work the duplex system? Mr. Fuller: Perfectly. Mr. Finlay: Or if the artificial cable were brought into correspondence with the real cable? Mr. Fuller: Yes; that would be the effect. Electrical cables, he proceeded, were subject to such faults, and there was no way to prevent them, and to repair the present one might cost anything from £30,000 to £80,000. Cross-examined by Mr. Webster: The short section of the company's cable from Torbay to New Hampshire, a distance of 560 miles, broke down at the same time as the longer one, in April, 1882, as far the working of the duplex system was concerned, but in April last that cable was repaired, two total disruptions having taken place. The duplex system would now work on that line, but it had not been applied, as it was unnecessary. They had given Messrs. Muirhead no notice of that repair, and had paid no royalties upon it to them. Witness had endeavoured to localise the fault in the main cable, and he believed it to be about 1,000 miles from Torbay. The company had a reserve fund of £340,000, for the purposes of effecting renewals and repairs. The device referred to in Messrs. Muirhead's specification for remedying leaks in the cable had no reference to such a condition as the cable was now in; it was impossible that the device mentioned could remedy the present defect.

Mr. Baron Huddleston, in giving judgment, said the way in which the plaintiffs' claim was framed was this: they said there was a contract between them and the defendant company by which the latter were to pay them £2,000 a year for the use of a patent which they had, so long as that patent operated satisfactorily; and if the duplex system did not operate satisfactorily, it was due to the negligence of the defendants, who did not keep their cable in reasonable repair. The statement of defence was that the duplex system did not operate properly, and that its failure was not due to any fault or negligence on the part of the company. Having read the articles of the agreement between the parties, he was of opinion that the defendants undertook that they would honestly endeavour to keep their lines in a condition to allow the duplex system to operate satisfactorily. Article 11. of the agreement seemed clearly to indicate that the patentees were to set the system going satisfactorily, and if they could not set it going, they were to pay the expenses and lose all the benefit; but if they did set it going they were to receive payment, and the company

was not at liberty to require that service from them again. He found it as a fact in evidence that the duplex system had worked satisfactorily for a period of four years, and it appeared to him to be a reasonable conclusion that the patent did operate satisfactorily within the meaning of the agreement, and in his judgment it was clearly through the default of the defendants that it did not continue to operate, and they must pay the money they had contracted to pay. He gave judgment for the plaintiffs for £1,000, with interest at the rate of 5 per cent. upon £500 from the 15th August, 1882, down to which period the royalty had been paid, and upon £500 from the 15th November, 1883.

Mr. Webster applied for, and was allowed, costs upon the higher scale. A stay of execution was granted, upon terms.

Christopher and Another v. Croll and Others.—This was an action which came before Mr. Justice Hawkins, sitting without a jury on Tuesday, arising out of matters which had happened 24 years ago. The plaintiffs, as the executors of one Thomas Allan, claimed £50,000 damages from the defendants for an alleged non-performance of a certain agreement said to have been made between him and the defendants, whereby it was agreed that a company should be duly incorporated to be called The United Kingdom Electric Telegraph Company, Limited, with a capital of £150,000 in £5 shares. Thomas Allan was to receive from the company in consideration for transferring his rights to certain telegraphic patents, the appointment of electrician at a yearly salary of £2,000, £10,000 in cash, and £15,000 in fully paid up shares, and a royalty of 10 per cent. on net profits after 5 per cent. had been paid to the shareholders. The defendants alleged that the agreement had been cancelled by a subsequent one between Allan and the United Kingdom Electric Telegraph Company. The plaintiffs in attempting to prove their case were met with the preliminary difficulty that the documents upon which they relied were not stamped and could not therefore be used in evidence till the penalty (£11 0s. 6d.) was paid. The learned Judge offered to adjourn the case to give the plaintiffs time to pay the penalty and instruct counsel; but this offer was refused, and the case proceeded. Eventually the learned Judge ruled that on the pleadings the plaintiff Hind had no right to appear as a plaintiff, and Mr. Christopher had entirely failed to make out his case, and would be nonsuited. Judgment accordingly for the defendants, with costs.

Muir & Co. v. Anglo-American Brush Electric Light Corporation, Limited.—Mr. R. H. Collins, Q.C., moved in the Court of Queen's Bench on Wednesday, before Mr. Justice Field, Mr. Justice Manisty and Mr. Justice Lopes, for a new trial in this action, which was to recover for an apparatus manufactured for the defendants, but which they refused to take or pay for, as they asserted it was not delivered until eight or nine months after the order was given, an undertaking having been entered into to complete the machine as nearly in eight or nine weeks as possible. Plaintiffs said they gave no definite undertaking, and found it much more difficult than they had at first imagined to construct the machine; they did their best to complete it as soon as possible. The case has several times been before the Court, a verdict having in the first place been given for the defendants by a Manchester jury; such judgment having been appealed against, new trials have been obtained, with a like result. Mr. Justice Field suggested an arrangement between the parties, whereupon Mr. Ambrose, Q.C., stated that £100 had been offered the plaintiffs for a machine that cost them £900, and this they could not consent to. Mr. Collins argued that there had been misdirection of the jury, and that the verdict was against the weight of evidence. Having heard the arguments of the respective counsel, their Lordships declined to grant an order for a new trial.

NEW PATENTS—1884.

9141. "Accumulators or secondary batteries." W. B. BRAIN. Dated June 18.

9163. "Apparatus for transmitting and collecting currents in electric railways." M. H. SMITH. Dated June 19.

9176. "System of regulating the feed of carbons used in electric arc lamps." W. R. OSWALD, W. R. FOSTER. Dated May 8.

9182. "Holders for incandescent electric lamps." A. SWAN. Dated June 19.

9185. "Holders for incandescent electric lamps." A. SWAN. Dated June 19.

9195. "Production of plates or electrodes for secondary batteries." H. J. HADDAN. (Communicated by L. Epstein.) Dated June 19.

9211. "Arrangements of telephonic apparatus." S. P. THOMPSON. Dated June 20.

9230. "Combining the posting or publication of telegraphic or other news or intelligence with advertisements." C. J. CHUBB. Dated June 20.

9232. "Protection for suspended wires." E. TOMLINSON. Dated June 20.

9265. "Obtaining motive power by the electric current (electro-motor or armature)." R. B. GANT. Dated June 21.

9309. "Manufacture of cells for galvanic batteries." J. B. SPENCE, H. A. FERGUSSON. Dated June 23.

9310. "Portable electric alarum or time signal." H. C. NEWTON. Dated June 23.

9326. "Electric regulating apparatus for clocks." H. J. HADDAN. (Communicated by P. Guisol.) Dated June 23.

9340. "Electrical motors." J. H. JOHNSON. (Communicated by A. W. Adams.) Dated June 24.

9341. "Electric motors for railway cars." J. H. JOHNSON. (Communicated by A. W. Adams.) Dated June 24.

9344. "Distributing and regulating electric currents." L. A. V. PELLEGRIN. (Communicated by G. Carette.) Dated April 3.

9353. "Construction of brush for conducting and imparting electricity to the human or animal frame." W. TAPP. Dated June 24.

9365. "Magneto-dynamo electric generators or electro-dynamo magnetic machines." A. SHIPPEY, J. E. WYDER. Dated June 24.

9369. "Electric belts or similar appliances and electrodes or terminals therefor." C. B. HARNESS. Dated June 24.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1883.

5153. "Electric clocks." S. SCHISGALL. Dated October 30. 6d. Relates to electric clocks, and is designed to provide a clock of this character differing from all others existing; by reason of the simplicity of the mechanism, which puts the hands in motion, and of the fact that the said clock is maintained in action by means of a galvanic current passing through an electro-magnet.

5158. "Incandescent electric lamps, &c." A. SWAN. Dated October 30. 6d. Consists in providing, at or about the neck of the globe or bulb of the lamp, grooves, or ribs, or depressions, or projections, and upon the holder or support, springs, which engage with the said grooves, or ribs, or depressions, or projections, so as to retain the globe or bulb in place in the holder or support. The said springs may themselves be of an ornamental character, or they may be concealed by, or contained within, an ornamental part of the holder. The terminal wires may be connected to the conducting parts of the holder either by the loops thereof being secured between jaws therein, as described in the Specification of Patent 2528, A.D. 1883, or the wires may simply project, and be held between such jaws, or between or against any other conductor. Where the fastening described in the said specification is employed, the tail ends of the springs, or one or more of them arranged as hereinbefore described, may be utilised as the springs for retaining the parts of the holder together, according to the said prior specification. Where the terminal wires project at the side of the neck of the bulb they may be brought into contact with two of the retaining springs, which will form a part of the conducting circuit.

5159. "Incandescent electric lamps." J. SWINBURNE. Dated October 30. 2d. Consists chiefly of a method of making carbon filaments. The inventor uses cotton, paper, or any other suitable form of cellulose, and acts on it with very strong nitric acid—this converts it wholly or partially into a jelly-like substance. He washes this, and treats it with a suitable reducing agent, and so converts it into a less combustible substance, of somewhat similar physical appearance. After reduction, the filaments may be carbonised and inclosed in bulbs in the usual ways. (*Provisional only.*)

5165. "Secondary batteries." I. L. PULVERMACHER. Dated October 30. 2d. The inventor spins lead-wire over a cord of thin metal, preferably composed of three distinct wires of different kinds, viz., a thin platinum wire, a copper wire, and a lead wire, as a compound core analogous to Gimp. The lead wire which is spun upon this compound core is spun with its coils a slight distance apart, to form interstices for the reception of a paste of oxide of lead (red-lead). (*Provisional only.*)

5166. "Galvanic batteries." I. L. PULVERMACHER. Dated October 30. 2d. Relates to certain construction or arrangement of cords of wires (platinum, copper, and lead) coated with cotton spun on in slightly distant coils, these compact wires are then wound upon a cylinder of porous clay in spiral order, and in contact therewith. The appliance or element thus prepared or made up is placed in a retort charged with coal or hydro-carbon gas, and heated to the desired degree to burn or carbonise the cotton coating on the wires in a similar manner as the carbon filaments of the incandescent lamps are carbonised. The carbonised cotton serving as the negative part of the element when a zinc rod is inserted into the porous cylinder filled with an exciting liquid which permeates through the pores, and establishing the wet connection with the carbon envelope. (*Provisional only.*)

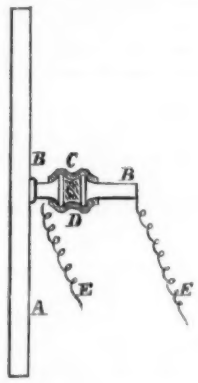
5177. "Armatures for electrical apparatus." F. C. GLASER. (Communicated by Messieurs. K. Luedtke and Grether, and A. I. Gravier, all of Russia.) Dated October 31. 2d. The invention is based upon the well known fact that when a sheet of paper is held over a magnetic field and iron filings are sprinkled thereon, the filings arrange themselves in what are called the magnetic curves or lines of force of the field. If now the small particles of iron are fixed in their position on the sheet of paper by means of a substance capable of being easily fused or melted, such for instance as solder or wax, an armature will be obtained which when set in a similar magnetic field to that which produced these special curves, will be best adapted to that field. (*Provisional only.*)

5180. "Electric burglar or fire alarm." F. J. HARRISON. Dated October 31. 6d. According to this invention, in an apparatus of suitable construction the inventor fits a portfire charged with a material giving when ignited a very powerful penetrating light, capable of illuminating a large area (magnesium for example), such portfire being ignited by means of an electric fuse, or the same may be ignited by percussion, as described. To the said apparatus is also attached one or more detonators or exploders capable of giving a loud report or series of reports, the same being contained in waterproof cases or compartments, the detonator or detonators communicate with the portfire by means of a fuse or fuses, in such a way that the same may be detonated either altogether or at fixed intervals.

5195. "Manufacture of porous pots and porous plates for galvanic batteries." T. COAD. Dated November 1. 2d. The inventor employs the ordinary clay from which porous pots or plates for galvanic batteries are usually made. The clay, after being thoroughly dried, is mixed with a carbonaceous solution; the solution which is found to answer well is a mixture of vinegar and sugar. A sufficient quantity of the solution is added to the clay to give it the proper consistency when it is moulded or formed into pots or plates in the usual manner. The pots or plates thus moulded or formed are dried and then placed in vessels for baking, the pots or plates being surrounded with a suitable carbonaceous matter such as plumbago. The vessel containing the pots or plates is then hermetically closed and subjected to the necessary heat usually employed for producing the ordinary porous pots.

5198. "Electric telephone transmitting and receiving instruments." A. F. ST. GEORGE. Dated November 1. 4d. Relates to telephonic apparatus, and it has for its object improvements in the construction of parts of such apparatus so that the audible signals are clearer and more distinct than has ordinarily heretofore been the case. (*Provisional only.*)

5201. "Telephone transmitters." G. L. ANDERS. Dated November 1. 6d. Relates to telephone transmitters of that class wherein there are electrodes so arranged that variations of their contact pressure will cause variations of the resistance in the circuit in which the transmitter is included. The objects of the invention are to increase the efficiency and simplify the construction of such instruments, and these objects are effected chiefly by the employment of osmium in the manner hereinafter described.



The fig. is a side view, partly in transverse section, of part of a transmitter with the invention applied to the same. A is the diaphragm, which may be made of any suitable material. B B are the electrodes, which are preferably formed of any metal not easily oxidised or fused. The granulated osmium is placed between two discs or pieces forming the electrodes and enclosed in a tube or sleeve of India rubber, cork, or other suitable material as shown.

5210. "Electro-magnetic machines." N. ROLLAND and H. B. FORD. Dated November 2. 2d. Consists of a series of compound permanent magnets arranged radially and concentrically around a central axis, with their poles presented thereto. Upon the central axis, which is suspended on suitable bearings or centres, so as to freely revolve, is fixed an inner ring of radial electro-magnets with their poles presented outwards, so as to pass, when the axis revolves, in front of the poles of the permanent fixed magnets. (*Provisional only.*)

5251. "Receiving instrument of speaking telephones." H. J. ALLISON. (Communicated from abroad by J. H. Robertson, of America.) Dated November 6. 6d. Relates to a telephone receiver in the secondary circuit of the induction coil in the primary circuit of which is the transmitter, the secondary circuit being so arranged that the induced current passes through vibrative electrodes, as well as the helix of the receiving electro-magnet as herein described, whereby the changes produced in the primary current by the vibrations of the transmitting diaphragm are accompanied by simultaneous changes in the secondary current produced by the corresponding vibrations of the receiving diaphragm.

5252. "Electric lamps." H. J. HADDAN. (Communicated from abroad by F. H. Werner and L. Ochse, both of the German Empire.) Dated November 6. 2d. This invention relates to an electric lamp adapted to serve at will as an incandescent lamp, or as an arc lamp, or as both together. (*Provisional only.*)

5263. "Galvanic batteries." C. D. ABEL. (Communicated from abroad by G. Przibram, H. Scholz, and W. Wenzel, all of Vienna.) Dated November 6. 4d. Relates to an improved construction of constant elements for galvanic batteries. The galvanic element is composed of two electrodes which may either both be of metal, or one of them may be of a mineral substance, and three conducting liquids, these parts being disposed in a vessel divided by means of two diaphragms or partitions into three compartments. The positive electrode, which is made either of platinum, carbon, or silver, is placed in a compartment of the element containing pure nitric acid of from 30° to 40° Beaumé. The negative electrode is placed in a second compartment of the element, containing a solution of one part by weight of common salt in about 20 parts by weight of water, or filled with some alkaline liquid. The third compartment of the element, separated from the other two by a porous diaphragm made of clay or other suitable porous substance, contains concentrated sulphuric acid of from 50° to 70° Beaumé. (*Provisional only.*)

5272. "Production, regulation, and utilisation of electric and magnetic forces." J. S. FAIRFAX. Dated November 7. 10d. A part of this invention consists in improved methods of joining together either single or multiple pieces of short or comparatively short portions of conductors, so as to facilitate the operation of placing them in position upon any required form or kind of core, and of connecting them to a commutator (where one is employed), provision being made for the passage of induced or transmitted currents in a straight, spiral, helical, or convoluted path, from each coil, fold, or series thereof, to those adjacent; or to any other point required.

5293. "Commutators of electrical machines." J. H. JOHNSON. (Communicated from Z. T. Gramme, resident at Paris.) Dated November 8. 2d. Relates to dynamo-electric and electro-dynamic machines and combination of devices hereinafter described for operating the commutator brushes or rubbers by causing the brush holders or carriers to oscillate simultaneously upon supports arranged as hereinafter explained. In place of an oscillating motion, the brush holders may be caused to partake of any other equivalent motion towards or from the commutator. (*Provisional only.*)

5325. "Carbons for incandescent electric lamps." J. WAVISH, J. WARNER, and M. BAILEY. Dated November 10. 4d. Has partly for its object to effect an improvement on the carbon, described in the Specification of Letters Patent, No. 39, granted to the said J. Wavish and J. Warner as of the 2nd January, 1883. According to this part of the invention, in place of bars as there described formed by making slots in a turned down or reduced central portion, the inventors connect the end pieces by a helix or coiled piece or filament or ribbon of carbon, there being spaces between the convolutions through which the light from the inner surface shines. According to a further part of the invention they form the carbon of a helix or coiled piece or filament or ribbon of carbon without end pieces, and they connect the respective ends of the said helix, or the like, to the terminal wires which enter the bulb of the lamp, the sockets or clips to receive the said ends being flattened or otherwise formed to receive the said ends and give good electrical contact.

1884.

4107. "An improvement or improvements in compound magnets." S. H. PARKES. Dated February 28. 6d. In constructing a compound magnet according to the invention, the inventor takes a wire or rod of steel and bends it into a symmetrical zigzag form. The bends may either be angular or curved. When the bends are angular the intermediate parts are inclined at a small angle to each other. When the bends are curved the intermediate parts are parallel, or nearly parallel. He magnetises the zigzag wire or bar either by a powerful steel magnet or by an electro-magnet, the exciting magnet being so applied to and moved upon the zigzag that all the adjacent angles or curves at one edge of the zigzag are operated upon by one pole of the exciting magnet, and all the adjacent angles or curves at the other edge of the zigzag by the other pole of the magnet. There is thus produced a compound magnet in the form of a flat zigzag, each angle or curve at one edge having north polarity, and each angle or curve at the other edge having south polarity.

5390. "An improvement in telegraphic systems." W. P. THOMPSON. (A communication from abroad by C. G. Burke, of America.) Dated March 25. 6d. The invention more particularly relates to the class of electric telegraphs in which the messages transmitted are indicated by the frequency, duration, and character of electric impulses rather than to the class in which electric currents or impulses are employed for actuating or controlling mechanism constructed to print or stereotype the message in letters or words. The invention is nevertheless also applicable to the last-mentioned systems of telegraphy and telegraphic apparatus.

5408. "An improved method of producing electrotyping moulds from typographic printing and other similar surfaces." W. LOWE and D. CAVAGNA. Dated March 25. 2d. Relates to the moulds employed in producing "electros" for typographic printing, and in producing other electrotypes of a similar character, and has for its object to produce such moulds in a shorter space of time and at a lower cost than heretofore has been practicable.

CORRESPONDENCE.

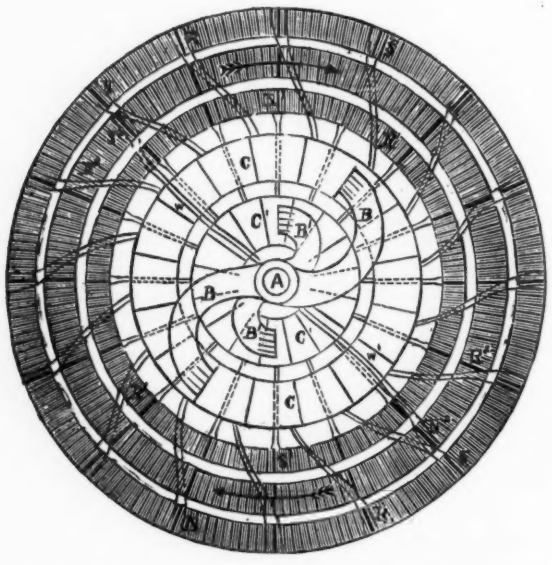
Continuous Current Inductional Transformers.

From Mr. E. L. Voice's letter which appeared in your last issue I must conclude that he has either patented the induction of continuous currents by means of any apparatus whatsoever, or imagines that he has done so. If the former supposition be correct, Mr. E. L. Voice's specification must be one of those "which may be said to include everything and mean nothing;" therefore, remembering the melancholy fate which invariably befalls these patents in courts of law, it seems that the value of this all-embracing one of Mr. E. L. Voice's cannot be very considerable. The apparatus with "a combination of concentric magnets," &c., &c., which Mr. E. L. Voice mentions in the concluding portion of his letter, appears to be the "motor induction machine" described in the ELECTRICAL REVIEW some time back, but the great differences existing between this apparatus and my inductional transformers are so obvious that it would be needless for me to occupy your valuable space with an enumeration of their essential points of dissimilarity.

The fact that Mr. Rankin Kennedy has failed in an attempt to induce continuous currents in a secondary circuit wound on a Gramme ring will certainly not deter me from thoroughly investigating the matter, and, should the double ring apparatus likewise prove a failure, I will then endeavour to discover the reason of its non-success, and, in any case, will communicate my results to the ELECTRICAL REVIEW.

Mr. Rankin Kennedy's objection that my proposal is an attempt at perpetual motion is somewhat surprising, for such an idea never entered my mind; of course the use of such an apparatus, as with all other transformers, would entail a loss more or less considerable, according to the efficiency of the arrangement.

Mr. Rankin Kennedy also considers that the motion of the poles in the ring would not induce currents, as it is necessary that the ring itself should rotate; assuming this objection to be correct, it is met by the transformer illustrated in the appended figure.



It will be remembered that the apparatus, as figured in my article of the 14th, consists of two fixed Gramme rings, each provided with a commutator and brushes. The transformer diagrammatically illustrated above, differs from it in the insertion of a Gramme ring without commutator, and capable of rotation, between the exterior and interior fixed rings. In the figure, R R is the exterior ring, C C its commutator, B B the brushes rubbing on this commutator. These brushes are attached to the axis, A, which also carries the brushes, B^1 B^1, which rub on the commutator C^1 C^1 of the ring R^1 R^1, between the rings R^1 R^1 and R R is the ring R^2 R^2, this ring is fixed to the axis, A, having no commutator, it is not wound in small sections but with two coils, each covering half the ring; the ends of these coils are connected together and, with the wires, W W^1, by means of which they are placed in circuit with the ring. R^1 R^1. On causing a current to traverse the rings R^1 R^1 and R^2 R^2, diametrically opposite poles N^1 S^1 are induced in the former and the poles N^2 S^2 in the latter. The poles N^1 S^2 and S^1 N^2 attract each other, and, as R^1 R^1 is fixed and R^2 R^2 capable of rotation, being attached to the same axis as the brushes, B^1 B^1, the poles in the fixed ring recede as fast as those in the moving ring approach them, thus causing the ring, R^2 R^2, to rotate in the direction shown by the arrows. This rotary motion of the poles N^2 S^2, induces currents in the coils of the ring, R R, which are collected by the brushes, B B. N S are the two secondary poles which, of course, are induced in the iron core of R R by the currents circulating in its coils.

On considering the action of this transformer it will be obvious: that a counter electromotive force will be set up in the coils of the ring R^1 R^1; that this counter E.M.F. will depend on the speed of rotation of the ring R^2 R^2, which in turn will depend upon the current traversing the coils of R R, this again will be determined by the resistance of the circuit external to R R, therefore if this resistance be infinite, the speed of rotation and, consequently, the counter E.M.F. will be at their maximum and the current traversing the primary rings at its minimum. On lowering the external resistance sufficiently to allow a current to pass, the speed of rotation of R^2 R^2 would diminish, thus decreasing the counter E.M.F., and allowing more current to pass through the coils of the primary rings. Therefore the current traversing the primary circuit is proportional to that traversing the secondary circuit.

This is perfectly in accordance with the experiments of Mr. Rankin Kennedy with induction coils and alternating currents as described in your journal during June, 1883.

An apparatus capable of being worked as a double or triple ring transformer will be completed before long, and the results of the investigation which I shall then commence will, with the permission of our esteemed Editors, form the subject of an article in the ELECTRICAL REVIEW.

F. de Wolffers.

St. John's Wood, *June 22nd*, 1884.

The New Patent Act.

Some three months ago there was some correspondence on the question whether, by virtue of the New Patent Act, patents granted before the new Act were liable to be made void under the provisions of the old law, and clauses 45 and 113 of the new Act were referred to. It may interest some of your readers to learn that the Judicial Committee of the Privy Council has recently decided, in the case of the application for the prolongation of the patent for the "Doty" light, that the rights of patentees under the old law were saved to them by the 113th clause of the new Act; by a parity of reasoning it would appear that the liabilities and obligations under the old law were also continued to patentees under that law.

H. B. T. Strangways.

5, Pump Court, Temple, E.C.,
June 24th, 1884.

Telephonic.

Would you, or any of your readers experienced in telephone engineering, kindly answer the following question:—

If I have a telegraph line 16 miles long, with eight busy wires along one side of a road—say a good broad highway—and a telephone line also 16 miles long along the other side of the road, the telegraphing will certainly be heard on the telephone line, but will conversation be seriously disturbed?

L.

Copenhagen, *June 23rd*, 1884.

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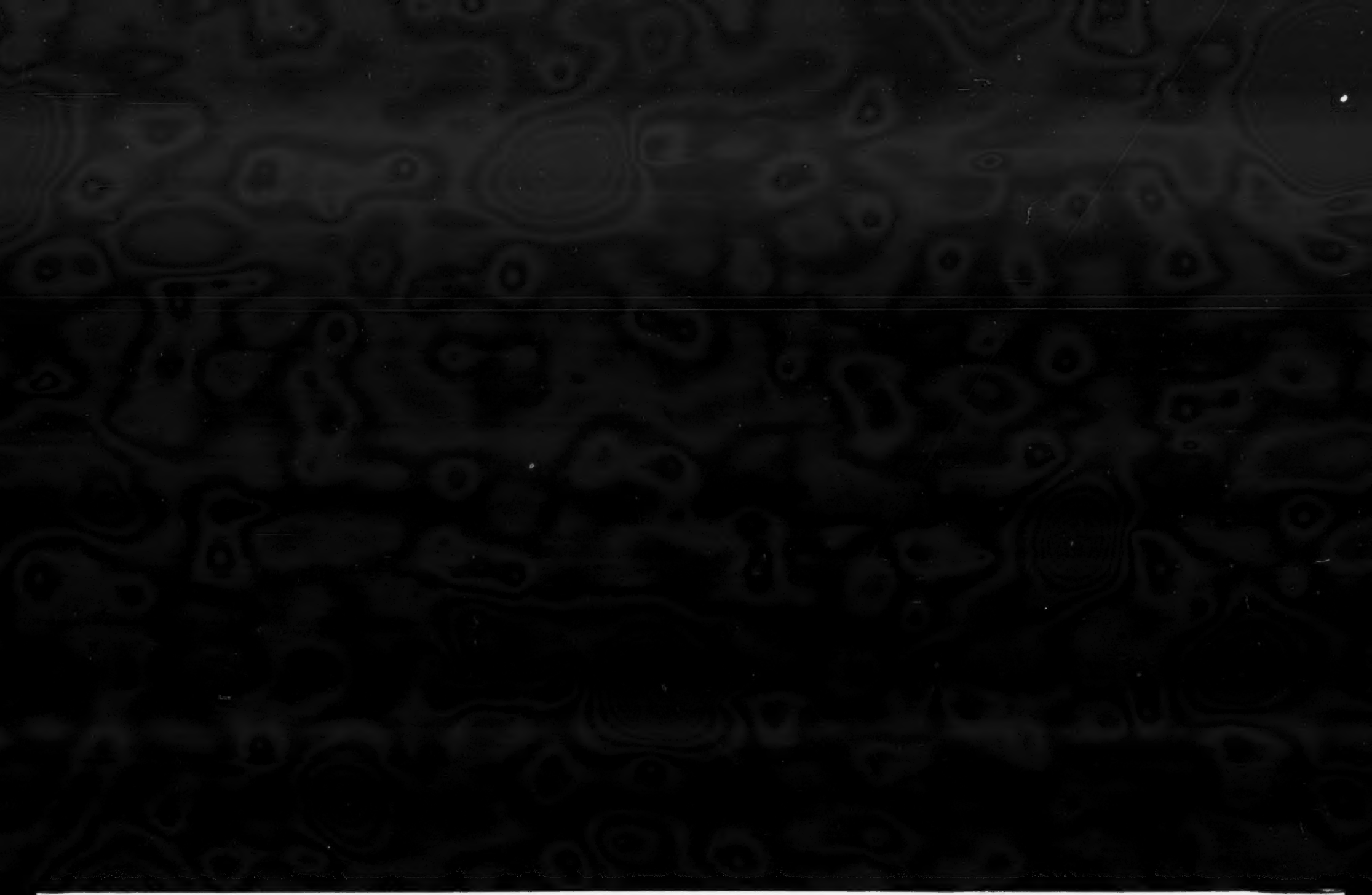
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